HUMAN BIOLOGY
a record of research
DECEMBER, 1939
VOL. 11 No. 4

SUPERNUMERARY NIPPLES, CONGENITAL HEMIHYPERTROPHY AND CONGENITAL HEMIATROPHY

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SLIGHT asymmetries of structure in bilaterally symmetrical organisms may be a consequence of imperfections in the mechanism which creates symmetry during early development. Such asymmetries must be expected to show a chance distribution with regard to the two sides of the body. But there are many striking asymmetries, certainly not falling into this class, which show a definite predilection for one body side. For instance, polydactyly in fowl is much more frequently expressed on the left foot than on the right, or, the skull deformities, which seem to determine hereditary cross-beak of chickens, occur much more frequently in such a way as to cause deviation of the upper beak toward the right side than do those which are responsible for the opposite type of abnormality (Landauer(21)). In both these instances we are dealing with genetic traits, but we do not know if the asymmetric features of the character expression are determined by hereditary factors. In the case of inherited foot abnormalities of mice Little (25) has demonstrated by selection experiments that the right-left incidence of these abnormalities is influenced by genetic modifiers.

Even in this instance, however, we are entirely ignorant of the ways in which such asymmetries with preferential incidence on one side are brought about.

In addition to structural ones there are striking functional asymmetries which show a definite preference of one side with regard to incidence, such as right- and left-handedness in man. These functional asymmetries presumably have a morphological basis, though, as yet, we do not have satisfactory proof for it. Various attempts have been made to show that a correlation exists between handedness and the occurrence of different types of abnormalities or of pathological processes on one or the other side of the body (Galippe(15), Faure (13), Beretta(5), Stier(37), and numerous more recent publications dealing with special problems). On the basis of rather meager data Stier advanced the hypothesis that partial hypertrophies and *Luxusbildungen* (supernumerary organs, etc.) occur on that side of the body which is innervated by the dominant hemisphere, while hemiatrophies and developmental retardations are found on the opposite body side. Stier believed that this rule holds always for left-handed persons and that it applies in principle, though not without exceptions, to right-handed ones.

There is great need for detailed information concerning the nature of structural asymmetries and the relationship, if any, of such morphological inequalities to functional and cerebral asymmetries. Observations concerning morphological deviations from symmetry can easily be accumulated, but it will be difficult to obtain critical data on such traits as handedness as long as we do not have better criteria for classification than those available at present.

The following report is primarily concerned with hyperthelia (supernumerary nipples), but there is added some information concerning congenital hemihypertrophy and congenital hemiatrophy. Only unmistakable instances of supernumerary nipples have been included in our material, and for hemihypertrophy and hemiatrophy the data are limited to congenital cases. The diagnosis of handedness was based on hand preference in writing, eating (spoon), and cutting (knife), and on usage of one or the other foot in kicking a ball. In doubtful cases further inquiry was made.

The material was collected with the cooperation of the physicians and institutions enumerated in Tables 2, 3, 10, and 12. Grateful acknowledgement is made for this valuable assistance.

SUPERNUMERARY NIPPLES (HYPERTHELIA)

The different types of supernumerary nipples which occur in humans, their distribution on the body, the frequency of their incidence in populations, and other features regarding hyperthelia have been studied by a series of investigators. Most of the earlier information is critically reviewed in the extensive monograph by Kajava, Schroderus, Wallenius, and Wichmann(20). In collecting new data we wished to obtain information on the following points: (1) do differences exist between the two sexes with regard to the frequency of occurrence of supernumerary nipples? (2) does unilateral hyperthelia occur more frequently on one side of the body than on the other side? And (3), is there a relationship between the presence of supernumerary nipples and handedness?

Strikingly inconsistent results have been reported by different authors with regard to the frequency of occurrence of supernumerary nipples. The reason for this is to be found in divergencies of opinion concerning what represents a supernumerary nipple. We believe that the present study includes only cases about which no doubt could exist.

Our material was obtained during the physical examination of university and college students and of applicants to the Civilian Conservation Corps; in a few instances data came also from the examination of students in the public schools. The great majority of persons examined were between the ages of 18 and 25 years. The data were collected during a two-year period (1935/36 and 1936/37). Only during a part of the examinations were records kept concerning the total numbers of persons examined. These records show the following results (Table 1):

TABLE 1

Frequency of supernumerary nipples according to sex

	MALES		FEMALES		BOTH SEXES	
	Number examined	Cases with hyperthelia	Number examined	Cases with hyperthelia	Number examined	Cases with hyperthelia
1935/36	5970	102	3822	42	9792	144
1936/37	8334	175	2706	38	11040	213
TOTAL	14304	277	6528	80	20832	357

During the 1935/36 period 1.71 per cent of the males, but only 1.10 per cent of the females showed supernumerary nipples. In the 1936/37 data the frequencies amount to 2.10 per cent among the males and to 1.40 per cent among the females. Considering the whole material we found 1.94 per cent of hyperthelia among males, but only 1.20 per cent among females. Had the frequency of supernumerary nipples among women equalled that among men, there should have been 127 cases in the population which was examined; the difference between expectation and actual finding amounts to 47 ± 7.9. Thus, our data prove the existence of a considerably greater frequency of supernumerary nipples among men than among women. The most careful earlier investigation, i. e. that of Kajava, Schroderus, Wallenius and Wichmann, had indicated a similar sexual difference. These authors found, among a total of 16,265 persons examined, 4 per cent men and 1.4 per cent women with supernumerary nipples (see also Martin (26).

TABLE 2

Supernumerary nipples—1935/36

INSTITUTION	SEX	RIGHT BODY SIDE		LEFT BODY SIDE		NUMBER OF RIGHT-HANDED PERSONS WHO HAVE LEFT-HANDED RELATIVES
		Right-handed	Left-handed	Right-handed	Left-handed	
Woman's College Univ. N. Carolina (Dr. A. M. Gove)	♀♀	..	..	2	..	0
College of Wooster Wooster, Ohio (Dr. R. N. Wright)	♂♂	2	..	..	1	0
Stanford Univ. (Dr. C. E. Shepard)	♂♂	..	..	2	1	1
New York Univ. (Dr. G. G. Deaver)	♂♂	1	..	2	..	?
McGill Univ.	♂♂	5	3	4	2	?
Cornell Univ. Ithaca, N. Y.	♂♂	5	2	5	3	2

TABLE 2 (*Continued*)

INSTITUTION	SEX	RIGHT BODY SIDE		LEFT BODY SIDE		NUMBER OF RIGHT-HANDED PERSONS WHO HAVE LEFT-HANDED RELATIVES
		Right-handed	Left-handed	Right-handed	Left-handed	
State Dept. of Health Chestertown, Md. (Dr. R. G. Beachley)	♀♀	1	..	..	..	1
Surgeon General's Office, War Dept.	♂♂	11	..	6	4	2
C.C.C. Company 2412 Jackson Springs, N. C.	♂♂	..	..	2	..	?
Personal observations	♀♀	..	..	1	..	1
	♂♂	..	..	1	..	0
C.C.C. Camp Dix, N. J. (Dr. B. F. Duckwell)	♂♂	24	3	42	5	?
Univ. of Wisconsin (Dr. C. E. Lyght)	♂♂	14	3	8	6	?
	♀♀	1	..	2	..	?
Univ. of Michigan (Drs. W. E. Forsythe and Margaret Bell)	♂♂	28	4	22	8	14
	♀♀	4	1	14	..	?
Connecticut State Coll. (Dr. R. L. Gilman)	♂♂	4	2	7	3	2
	♀♀	1	..	..	..	0
Univ. of Kansas (Dr. R. I. Canuteson)	♂♂	2	..	2	1	1
	♀♀	..	..	2	..	1
Univ. of Minnesota (Dr. R. E. Boynton)	♂♂	..	..	..	2	..
	♀♀	5	3	10	1	(3 out of 9)
Mass. State Coll. (Dr. E. J. Radcliffe)	♂♂	22	3	28	13	?
	♀♀	..	2	5	..	?
TOTAL	♂♂	118	20	131	49	
	♀♀	12	6	36	1	
	ALL	130	26	167	50	28 out of 111

TABLE 3

Supernumerary nipples—1936/37

INSTITUTION	SEX	RIGHT BODY SIDE		LEFT BODY SIDE		NUMBER OF RIGHT-HANDED PERSONS WITH LEFT-HANDED RELATIVES
		Right-handed	Left-handed	Right-handed	Left-handed	
Stanford Univ. (Dr. W. H. Northway)	♂♂	..	..	3	..	0
Woman's College Univ. N. Carolina (Dr. A. M. Gove)	♀♀	..	..	4	1	..
White Plains Public Schools, White Plains, N. Y. (Dr. V. M. Palmer)	♂♂	5	1	9	..	..
Cornell Univ. (Dr. D. F. Smiley)	♂♂	..	1	2	..	1
Cornell Univ. (Dr. Jennette Evans)	♀♀	6	3	13	3	5
Univ. of Utah (Dr. H. L. Marshall)	♀♀	2	..	..	1	2
Vanderbilt Univ. (Dr. T. B. Zerfoss)	♂♂	11	2	4	..	0
Dr. R. E. Glendy Boston, Mass. High School	♂♂	1	..	..	..	0
Orange, Mass. (Dr. K. L. Alexander)	♂♂	..	..	1	..	0
Public Schools East Orange, N. J. (Dr. W. B. Nevius)	♂♂	7	2	5	1	0
Columbia Univ. (Dr. W. H. McCastline)	♂♂	1	..	..	1	0
Phillips Academy (Dr. J. R. Gallagher)	♂♂	..	2	1	2	0

TABLE 3 (*Continued*)

INSTITUTION	SEX	RIGHT BODY SIDE		LEFT BODY SIDE		NUMBER OF RIGHT-HANDED PERSONS WITH LEFT-HANDED RELATIVES
		Right-handed	Left-handed	Right-handed	Left-handed	
Univ. of Chicago	♂♂	..	1	6	3	3
(Dr. R. E. Taylor)	♀♀	..	..	2	..	0
Univ. of Michigan (Drs. W. E. Forsythe and W. M. Brace)	♂♂	18	2	16	2	14
Princeton Univ. (Dr. W. H. York)	♂♂	..	..	1	1	0
Name omitted by request	♂♂	7	2	9	2	4
Univ. of Wisconsin	♂♂	14	2	22	3	7
(Dr. L. R. Cole)	♀♀	1	..	1	..	0
Connecticut State Coll.	♂♂	7	1	5	2	5
(Dr. R. L. Gilman)	♀♀	1	1	..	..	1
N. J. Coll. for Women (Dr. E. E. Kleiber)	♀♀	1	..	2	..	0
Univ. of Minnesota	♂♂	5	..	2	..	2
(Dr. R. E. Boynton)	♀♀	11	2	11	3	7
Mass. State College	♂♂	8	2	4	2	1
(Dr. E. J. Radcliffe)	♀♀	1	..	1	..	1
Univ. of Kansas	♂♂	7	5	12	6	3
(Dr. R. I. Canuteson)	♀♀	1	1	..	1	1
Public Schools Kenmore, N. Y.	♂♂	1	..	6	2	1
(Dr. R. W. Weiser)	♀♀	4	1	4	1	4
Easton High School Easton, Pa. (M. S. Coyle, R.N.)	♂♂	..	1	..	..	..
Personal observation	♂♂	..	..	1	..	0
TOTAL	♂♂	92	24	109	27	
	♀♀	28	8	38	10	
	ALL	120	32	147	37	62 out of 249

The detailed data concerning incidence on the left or right side of the body are presented in Tables 2 and 3. All cases of approximately equal development of supernumerary nipples on the two sides of the body are omitted from this tabulation. The great majority of cases are unilateral, but there are included a few bilateral cases in which one body side showed a definite preponderance in the degree of hyperthelia. The results with regard to incidence are summarized in Table 4.

TABLE 4

Numbers of individuals with supernumerary nipples according to body side of occurrence and according to sex

	MALES		FEMALES		BOTH SEXES	
	Right	Left	Right	Left	Right	Left
1935/36	138	180	18	37	156	217
1936/37	116	136	36	48	152	184
TOTAL	254	316	54	85	308	401

These figures suggest that supernumerary nipples are more frequently found on the left side of the body than on the right. A comparison of our findings with those of earlier investigators is of interest (Table 5).

TABLE 5

Relative frequency of hyperthelia on right and left side of the body

	RIGHT		LEFT	
	Total	Per cent	Total	Per cent
Literature data as summarized by Kajava *et al.*	2149	46.3	2487	53.7
Kajava *et al.*.....	264	44.4	330	55.6
Our own data.....	308	43.4	401	56.6
GRAND TOTAL.....	2721	45.8	3218	54.2

The several sets of data show surprising agreement with regard to the differences in frequency of hyperthelia on the right and left

side of the body. The excess of supernumerary nipples on the left side, above the 50 per cent expected by chance, amounts to 4.2 ± 0.65 per cent, and is significant. Without doubt supernumerary nipples occur more frequently on the left body side. Two authors, both with entirely inadequate data, came to the opposite conclusion, i. e. they believed that supernumerary nipples are more often found on the right body side. Stier(37), reported on 60 cases of which 48 were on the right, and 12 on the left side. He saw in this one of the proofs for his hypothesis that supernumerary organs in general show a higher incidence on the side opposite to that of the dominant cerebral hemisphere. Stannus(35), on the basis of 15 cases of hyperthelia, of which ten were on the right side, as well as in consideration of other data, thought that his material tended to confirm Stier's idea. However, from the abundant material which is available, it follows that the left side of the body shows a definite, though not very large, predominance in the incidence of hyperthelia.

Our observations suggest further that the predominance of the left side over the right, with regard to the occurrence of supernumerary nipples, is more striking in the female than in the male sex. Thus, among the 1935/36 data, 56.6 per cent of the men but 67.3 per cent of the women showed hyperthelia on the left side, and the corresponding figures for the 1936/37 material are 54.0 per cent and 57.1 per cent, respectively. These data are insufficient to verify the reality of the differences. We obtained very similar results, however, when we

TABLE 6

Unilateral cases of hyperthelia observed by Kajava, Schroderus, Wallenius and Wichmann, arranged in age groups

AGE GROUPS Years	MALES		FEMALES	
	Right	Left	Right	Left
1-10	10	11	6	12
10-15	20	22	12	18
15-20	9	12	1	5
20-30	42	56	5	8
Over 30	25	24	9	7
TOTAL	106	125	33	50
PER CENT	45.9	54.1	39.8	60.2

tabulated the unilateral cases of hyperthelia, observed by Kajava, Schroderus, Wallenius, and Wichmann, according to incidence on the two body sides and to sex (Table 6).

It can be seen that, with exception of the last age group, the predominance of incidence on the left side in every one of the groups is more conspicuous in females than in males. A summary of all available material is given in Table 7. The data in Table 6, together with our own, as given in Table 7, show for males an average incidence of supernumerary nipples on the left side of the body of 54.1 ± 1.07 per cent, while the corresponding figure for females amounts to 62.8 ± 4.18 per cent. The difference between these two means is 8.7 ± 4.31. It is true that this difference is only a trifle over twice the

TABLE 7

Relative incidence of hyperthelia on left side of body and according to sex

SOURCE	MALES		FEMALES	
	Number of all cases	Per cent on left	Number of all cases	Per cent on left
Our 1935/36 data.....	318	56.6	55	67.3
Our 1936/37 data.....	252	54.0	84	57.1
Data of Kajava *et al*.....	231	54.1	83	60.2
TOTAL.....	801	55.1	222	60.8

standard error, but in view of the fact that in six out of seven groups the females showed a higher incidence of supernumerary nipples on the left body side than did the males, it seems very likely that we are dealing with a real sexual dissimilarity. This conclusion is supported further by the fact that in the grouping given in Table 7 the ranges for the two sexes do not overlap; the frequency of supernumerary nipples on the left body side was 54.0 to 56.6 per cent in males, and 57.1 to 67.3 per cent in females.

Finally, we are interested to know whether or not there is any association between the occurrence of supernumerary nipples and the existence of left-handedness. Table 8 gives a summary regarding this question. It can be seen from this table that the percentage of

TABLE 8

Frequency of left-handedness in persons with hyperthelia. Distribution according to sex

GROUP	MALES			FEMALES			BOTH SEXES		
	Number with hyperthelia	Number left-handed	Per cent left-handed	Number with hyperthelia	Number left-handed	Per cent left-handed	Number with hyperthelia	Number left-handed	Per cent left-handed
1935/36	318	69	21.7	55	7	12.7	373	76	20.4
1936/37	252	51	20.2	84	18	21.4	336	69	20.5
TOTAL	570	120	21.1	139	25	18.0	709	145	20.5

left-handedness among persons with supernumerary nipples, with the exception of one small group, runs approximately between 20 and 22 per cent. In all, we had 709 cases of hyperthelia of which 145, or 20.5 per cent, were left-handed. These are very high percentages. In general, the frequency of left-handedness in adolescent or adult population groups is given in the literature as about 8 per cent. This is confirmed by our own observations when the same criteria for the determination of handedness were applied to all cases. There is little doubt that the frequency of left-handedness is much higher in the groups with supernumerary nipples than in those without supernumerary nipples. The somewhat lower incidence of left-handedness among the females as compared with males is in good agreement with the general experience that left-handedness occurs more commonly among males than among females (Wile(41)).

The material in Table 8 includes only the cases of unilateral hyperthelia, together with a few cases of bilateral hyperthelia in which one side showed predominance in number and/or development of the supernumerary nipples. In addition, we had a small group of bilateral cases in which number and development of the supernumerary nipples was about the same on the two sides. There were 35 persons in this group; 10, or 28.6 per cent, of them were left-handed. Again, this is a very high frequency of left-handedness.

There is, however, no indication of the existence of a correlation between handedness and the body side on which supernumerary nipples

occur. This is evident from the figures in Table 9 which show that left-handedness is about as frequent among persons with hyperthelia of the right side as it is among those with hyperthelia of the left side; a high frequency of left-handedness is found among all persons with hyperthelia, irrespective of the location of the supernumerary nipples.

TABLE 9

Relation of incidence of hyperthelia on right and on left body side to the existence of left-handedness

GROUP	HYPERTHELIA ON RIGHT SIDE			HYPERTHELIA ON LEFT SIDE		
	Number	Left-handed		Number	Left-handed	
		Number	*Per cent*		*Number*	*Per cent*
1935/36.....	156	26	16.7	217	50	23.0
1936/37.....	152	32	21.1	184	37	20.1
TOTAL	308	58	18.8	401	87	21.7

Some effort has also been made to determine the frequency of left-handed relatives among the right-handed persons of our material. This is of some interest because Steiner(36), in the case of epilepsy, has presented evidence suggesting that there is not only a high frequency of left-handed individuals among epileptics, but that there is also an abnormally high occurrence of left-handedness among the immediate relatives of right-handed epileptic persons. Our own information on this question is incomplete. For the data collected during 1935/36 we found that out of a total of 111 right-handed persons with unilateral hyperthelia 28, or 25.0 per cent, had left-handed relatives (grand-parents, parents, uncles and aunts, brothers and sisters), and during 1936/37 the corresponding figures were 62, or 24.9 per cent, out of 249 right-handed persons with unilateral hyperthelia. In general, the frequency of right-handed persons with left-handed relatives amounts to approximately eight to ten per cent, i. e. it is about the same as that of left-handedness in the population as a whole. It would seem, then, that right-handed persons with supernumerary nipples have left-handed immediate relatives more frequently than is to be expected on the basis of the incidence in the population at large.

Observations on supernumerary mammae should be of interest. The only case at our disposal concerns a woman with one supernumerary mamma on each side, the right one being larger than the left one. This woman is left-handed, and both her mother and two brothers are also left-handed.

HEMIHYPERTROPHY AND HEMIATROPHY

Hemihypertrophy is a rare developmental abnormality in which parts or all of one side of the body show an enlargement. This condition is congenital, but may partially or entirely disappear in later years. It seems to affect all tissues to a similar extent. It is frequently associated with a retardation in mental development and with cutaneous vascular disturbances, the latter not always being confined to the hypertrophic side.

An interesting summary of the literature concerning hemihypertrophy by Gesell(16) suggests that the right side of the body is involved more frequently than the left side. Among a total of 53 cases, there were 35 involving the right side, but only 18 (not 28, as is stated in Gesell's publications) concerning the left side. This is a proportion of about two right to one left. In order to determine whether or not this lateral difference is significant, a search was made in hospitals and institutions for further cases of hemihypertrophy. In this way we succeeded in obtaining information concerning 24 cases, including two already contained in Gesell's publication. Details about these cases are given in Table 10. There were 19 instances concerning the right side and only five concerning the left. This is an even more striking preference of the right side, with regard to the frequency of occurrence of hemihypertrophy, than that observed by Gesell. The material collected by Gesell, together with that reported here, shows among a total of 75 cases a distribution of 52 on the right side and of 23 on the left. There can be no doubt that hemihypertrophy is more frequent on the right side of the body. This conclusion has been drawn already by Stier(37).

With regard to handedness, the summary of Table 11 shows that there were six left-handed persons (25 per cent) in a total of 24 cases for which handedness is known. This is a high percentage, but the material is too small to be of statistical value.

We have, in addition, collected some information on congenital hemiatrophy. This condition is in many ways the counterpart of

TABLE 10

Cases of hemihypertrophy

SOURCE	SEX	BODY SIDE	EXTENT	HANDEDNESS	PUBLISHED CASE REPORT
Worcester State Hosp. Worcester, Mass. Dr. F. H. Sleeper	♂	R	thigh, leg, foot	R	.....
Deal Clinic Springfield, Ill.	♀	R	face	R	.....
Vanderbilt Univ., School of Med., Nashville, Tenn. Dr. Edgar Jones	♂	R	whole side	R	.....
Id.	♀	R	whole side	R	.....
Pownal State School Pownal, Me. Dr. S. E. Vosburgh	♀	R	whole side	R	.....
Columbia Univ., Coll. Phys. and Surg., N.Y.C. Dr. C. L. Wood	♀	R	whole side	R	.....
Personal observation	♂	R	whole side	R	.....
Worcester State Hosp. Worcester, Mass. Dr. Benjamin Simon	♂	R	chiefly leg	R	.....
Columbia Hosp. Pittsburgh, Pa. Dr. D. H. Boyd	♂	R	thigh, leg, foot	R	.....
New York Hosp., N. Y. C. Dr. R. R. Hannon	♀	R	leg, to lesser extent arm	R	.....
Clin. Child Development Yale Univ., New Haven, Ct. Dr. Arnold Gesell*	♂	R	whole side	R	*Arch. of Neurol. and Psych.*, 6; 400-423, 1921
Dr. A. C. Read* San Francisco, Calif.	♀	R	upper and lower extremity	R	*N. Y. Med. Jour.*, 118; 483, 1923
Kreiskrankenhaus Oschersleben, Germany Dr. Esau	♀	R	whole side	R	*Med. Klinik*, 27; 1861-1863, 1931

TABLE 10 (*Continued*)

SOURCE	SEX	BODY SIDE	EXTENT	HANDEDNESS	PUBLISHED CASE REPORT
Maine Gen. Hosp. Portland, Me. Dr. T. A. Foster	♀	R	upper and lower extremity	R	.....
Vanderbilt Univ., School of Med., Nashville, Tenn. Dr. Edgar Jones	♀	R	whole side	L	.....
Stanford Univ., School of Med., San Francisco, Cal. Dr. W. C. Black	♀	R	whole side	L	.....
Village for Epileptics Skillman, N. J. Dr. D. S. Renner	♀	R	upper extremity not definitely involved, otherwise whole side	L	.....
Maine Gen. Hosp. Portland, Me. Dr. H. E. Christensen	♀	R	leg	L	.....
Cincinnati Gen. Hosp. Cincinnati, Ohio	♂	R	whole side	ambidextrous	.....
Stanford Univ., School of Med., San Francisco, Cal. Dr. H. K. Faber	♂	L	whole side	R	.....
Dr. H. L. Updegraff Hollywood, Calif.	♂	L	face	R	*Am. Jour. of Surg.*, 10; 439-443, 1930
Orthopaedic Hosp. School Los Angeles, Calif. Dr. R. L. Carroll	♀	L	whole side	R	.....
Dr. George Halperin Chicago, Ill.	♂	L	whole side	R	*Arch. of Int. Med.*, 48; 676-682, 1931.
Clin. Child Development Yale Univ., New Haven, Ct. Dr. Arnold Gesell	♂	L	whole side	L	.....

* These two cases already included in Gesell's summary.

TABLE 11

Hemihypertrophy according to body side, sex and handedness

BODY SIDE	TOTAL NUMBER	SEX		HANDEDNESS	
		Males	Females	Right	Left
Right.....	19	7	12	14	5
Left.....	5	4	1	4	1
TOTAL.....	24	11	13	18	6

TABLE 12

Cases of hemiatrophy

SOURCE	SEX	BODY SIDE	EXTENT	HANDEDNESS
Milwaukee Co. Asylum for Chronic Insane, Wauwatosa, Wis. Dr. Frederic Storchheim	♂	R	face, arm, chest (to level of umbilicus)	R
Eastern State Hosp. Lexington, Ky. Dr. W. E. McWilliams	♂	R	whole side	L
Saint Elizabeths Hosp. Washington, D. C. Dr. John P. H. Murphy	♂	R	arm and leg (esp. hand)	L
Id.	♂	R	arm and leg (esp. hand)	L
Columbus State Hosp. Columbus, Ohio Dr. J. F. Bateman	♀	R	both extremities (possibly some involvement of trunk)	L
Clarinda State Hosp. Clarinda, Iowa Dr. R. D. Smith	♂	R	whole side	L
Children's Hosp. Cincinnati, Ohio Dr. W. E. Nelson	♀	L	whole side	R
Utica State Hosp., Utica, N. Y. Dr. R. H. Hutchings	♀	L	whole side	R

TABLE 12 (*Continued*)

SOURCE	SEX	BODY SIDE	EXTENT	HANDEDNESS
Dr. W. J. van den Berg Sacramento, Calif.	♂	L	face	R
Dr. W. J. van den Berg Sacramento, Calif.	♀	L	whole side	R
Wisconsin Gen. Hosp. Madison, Wis. Dr. Mabel G. Masten*	♀	L	whole side	R
Id.	♀	L	face, breast, thorax	R
N. Y. Hosp., N. Y. City Dr. R. R. Hannon	♀	L	face	R
Dr. H. F. Root. Boston, Mass.	♀	L	face, arm, leg	R
Clarinda State Hosp. Clarinda, Iowa Dr. R. D. Smith	♂	L	face	R
Laconia State School Laconia, N. H. Dr. B. W. Baker	♀	L	face	R
Id.	♀	L	chiefly face (body some ?)	R
Univ. Hosp., Iowa City, Iowa Dr. C. van Epps	♀	L	face	R
Id.	♀	L	whole side	R
Dr. H. L. Harding Liverpool, N. Y.	♂	L	arm, hand, trunk	R
Dr. A. P. Knight Waverley, N. Y.	♂	L	head, thorax	L
Wisconsin Gen. Hosp. Madison, Wis.	♀	L	whole side	L

* For case report see Masten (*27*).

hemihypertrophy. Data are presented on 22 cases of hemiatrophy (Table 12), 16 of which involve the left side of the body and only six the right side. With regard to incidence hemiatrophy seems to favor the side opposite to that preferentially affected by hemihypertrophy.

While there is no indication that hemihypertrophy interferes with the expression of the inherent handedness, the same, unfortunately, does not appear to be true for hemiatrophy. Many of the individuals with hemiatrophy of the right side seem to be left-handed on account of the weakness of the right half of the body. Hence, our data on handedness have no critical vlue.

DISCUSSION

Morphological and physiological differences between the left and the right side of the human body have been reported frequently, although in most instances there is great need for further investigation. We shall refer here to only some of the asymmetries which have been described. In particular, we have left out of consideration the many reports on slight skeletal and other asymmetries in adult persons which may well be secondary to the preferential use of the muscles on one side.

Galippe(15), in a series of papers, called attention to dental asymmetries. He found that the teeth of the right side are generally larger and have a higher density than those of the left; that the wisdom teeth appear less frequently on the left side than on the right; and that malformations of teeth are more common on the left side. He recorded that three left-handed persons had malformed teeth on the right side. Beretta(5) studied the sequence of eruption of the deciduous teeth, and found that if any asymmetry exists, eruption generally occurs earlier on the right side. According to Beretta the opposite is true in left-handed persons. The investigations of Ledé (24) however, make it probable that the situation is more complex. Additional data are needed which can be subjected to statistical analysis. One striking feature of Ledé's data is that they suggest the possibility that the side of first eruption of the deciduous teeth may be modified by nutritional factors.

In new-born children the centers of ossification usually are developed symmetrically. But Menees and Holly(28) observed that, where asymmetry exists, the right epiphyseal centers are more fre-

quently present than the left. They found also that in nine of eleven cases, of children which could be observed for a sufficient length of time, the hand used by preference agreed with the side on which the epiphysis appeared first.

According to Yamazaki(43) there is already before birth a difference in size of the left and right half of the lower jaw, the left generally being the larger.

Camurati(10) found that congenital pseudoarthrosis of the tibia (98 cases) occurred in 54.1 per cent on the left and in 45.9 per cent on the right side. Among 59 cases of congenital dislocation of the hip joint, enumerated by Aschner and Engelmann(4), there were 34 on the left side and 25 on the right; according to Lange(22), a majority of the bilateral cases are more severe on the left side.

TABLE 13

Summary of unilateral cases of defects of long bones according to side of occurrence

MALFORMATION	NUMBER OF UNILATERAL CASES	BODY SIDE Right	Left	PER CENT On right	AUTHOR
Defect of femur (partial or total)	28	15	13	53.6	Blencke (8)
Total defect of tibia	18	13	5	72.2	Nuzzi (31)
Partial defect of tibia	14	11	3	78.6	Nuzzi (31)
Total defect of fibula	45	24	21	53.3	Antonelli (2)
Partial defect of fibula	20	12	8	60.0	Antonelli (2)
Defect of ulna (partial or complete)	15	11	4	73.3	Wierzejewski (40)
Total defect of radius	41	26	15	63.4	Antonelli (3)
Partial defect of radius	11	8	3	72.7	Antonelli (3)
All defects of long bones	192	120	72	62.5	

An analysis of some of the reviews concerning partial or total defects of long bones on one body side (Table 13) reveals that all the different types of long bone defects are more common on the right side than on the left. In the total material the deviation from equality amounts to 12.5 $\pm$ 3.60; this difference is three and one-half times its standard error, and, hence, is significant.

Among 147 cases of uncomplicated harelip Sanders(33) found 89, or 60.5 per cent, on the left side; among 137 cases of harelip with cleft palate there were 85, or 63 per cent, on the left side. The preferential occurrence on the left side is more striking in females than in males: for uncomplicated harelip the figures are 62.7 per cent for females and 59.8 per cent for males, while the corresponding data for harelip with cleft palate are 65.2 per cent for females and 60.4 per cent for males. In addition, Sanders finds that in bilateral cases the condition tends to be more severe on the left side. There seems to be an increased frequency of anatomical and mental defects in the individuals with cleft palate as well as among members of their families.

Danforth(11) reported that unilateral absence of the palmaris longus muscle is much more common in the left arm than in the right, and that the existence of three heads is more frequent in the left biceps muscle than it is in the right. Among the unilateral cases of suppression of the palmaris longus muscle the deviation from a chance distribution is greater in females than in males.

Interesting differences in the number and amounts of veins visible on the dorsal surface of the right and left hand were observed by Minor(29). He found that a great majority of right-handed persons have more visible veins on the right hand, while the opposite is true in a still higher percentage of cases among left-handed persons. These differences can already be seen in children, and presumably are congenital. Leche(23) and Newman(30) found that the patterns formed by the lines of the palms and fingers show marked differences between the left and right hand, and that the distribution of this bilateral symmetry is generally associated with handedness, i. e. the predisposition of various types of patterns and lines to predominate in either right or left hand tends to be the opposite in left-handed persons from what it is in right-handers. Piebenga(32), observed sexual differences with regard to the frequency distribution of these pattern asymmetries: in some patterns the females showed greater asymmetry, in other patterns the males. It is also interesting in this connection that Abel(1) described abnormalities of finger and palm patterns in mentally abnormal persons (criminals, mongoloid idiots, deaf-mutes, etc.) and in individuals with morphological malformations; he was unable to find the same type of abnormality in a normal population.

With regard to strabismus, Fink and Bryngelson(14) reported among 60 children that in 61.7 per cent the left eye was involved and

only in 38.3 per cent the right. There were 41.8 per cent of ambidextrous individuals in this group, most of whom presumably were inherently left-handed. Familial left-handedness was recorded in 74 per cent of the cases!

The foregoing and still other available evidence indicates that the preferential occurrence of supernumerary nipples on the left side of the body is not an isolated instance, but that the human body shows numerous morphological asymmetries with a predilection for one side. In most cases, however, further data are needed to put our knowledge on a secure basis.

There is also evidence that sexual differences in the degree of asymmetry, such as the greater tendency of females to show a deviation from chance distribution with regard to supernumerary nipples, exist in other abnormalities, e.g. the cases of absence of the palmaris longus muscle and of hare lip and cleft palate, but some are of the reverse type, i. e. the more extreme asymmetry of incidence occurs in the male. Thus, Menees and Holly(28) reported that they found lack of symmetry with regard to ossification somewhat more frequently in new-born boys than in girls, and Sawtell(34) confirmed this with regard to various irregularities of ossification in children of ages between one and eight years. Inglessis(19), studying the symmetry conditions of the cranium on a material of 96 cases, only five of which were perfectly symmetrical, observed that the deviations of the asymmetries from a chance distribution were much greater in males than in females. Among the male crania the left side was larger in 70.4 per cent, the right side in 24.8 per cent; among the female crania the corresponding figures were 57.4 per cent and 37.1 per cent, respectively.

The literature quoted above as well as other evidence also indicate that the existence of developmental abnormalities is frequently associated with a high incidence of left-handedness. It is quite possible, of course, that such groups, in addition, contain a high percentage of "extreme" right-handers (Bethe(7)) who at present cannot be diagnosed.

Some of the traits to which reference has been made are known to be hereditary, and it is likely that all are influenced, if not determined, by genetic factors. But it is doubtful if the same is true with regard to the features of asymmetry in which we are particularly interested here. Speaking of abnormalities which occur bilaterally as well as unilaterally Danforth(11) says that "so far as the evidence goes there

is no indication that the unilateral appearance of a variation differs genetically from the bilateral," and he resigns himself to the statement that "the sides of the body and the sex of the individual act as definite influences in favoring or tending to inhibit the appearance of various traits represented in the germ-plasm." It is the nature of these influences about which one would like to have information.

It is evident from the facts which have been reviewed that the mechanism which is responsible for asymmetry, whatever its nature, affects very different organs and systems in a similar fashion and that it must act during comparatively early stages of development. It is unlikely that conditions of the uterine environment should produce similar responses in so many different structures, and the fact that sex acts as a modifier indicates clearly that we are dealing with an agency *within* the developing embryo.

It was shown by Wright(42), for rabbit and fowl material, that the growth rates of different parts of the body differ from general body growth by slight but significant amounts. It is suggested that such local or lateral differences in growth intensity and in the fundamental metabolic activities underlying growth may furnish the mechanism by which preferential asymmetry is brought about.

This still leaves open the question concerning the nature of the ultimate determiners of the physiological processes which modify development asymmetrically. If it is unlikely that these effects are due to specific genes, two principal alternatives of explanation seem open. The first, which was suggested by Sumner and Huestis(38) on the basis of a study concerning skeletal asymmetries in *Peromyscus*, involves the assumption of factors within the cytoplasm of the egg and of spatial affinities between certain parts of the egg cytoplasm and substances in the sperm nucleus. As a second alternative, it might be assumed that in higher vertebrates, especially in man, the central nervous system has a trophic function in development and that in this way it acts as a modifying agency.

There is some evidence which seems to fit the hypothesis that unequal differentiation of the hemispheres and possibly of other parts of the central nervous system, including the spinal cord, with consequent differences in trophic stimulation, furnish the basis for asymmetric morphogenetic processes by way of unspecific inequalities in growth. There is, to start with, the association between morphological asymmetries and handedness which points to a common cause in the domi-

nance of one of the hemispheres. Furthermore, with reference to the predilection of congenital hemihypertrophy for the right side of the body and the similar prevalence of congenital hemiatrophy on the left side, it is of interest to note that mental subnormality is found in most of these cases (see Gesell(16), Masten(27)). Masten reported a conspicuous reduction in the size and number of nerves on the atrophic left side of a patient with congenital hemiatrophy, with some evidence of abnormality of the cerebral cortex, especially on the right. Enderle(12) described a case with a complex of abnormalities, including lack of the right radius, shortening of the right ulna, rudimentary development of the right thumb, and relatively small size of the right mamma and shoulder blades, which he attributed to the existence of lesions of the mesencephalic centers (paleostriatal lesions). Boenheim(9) with very inadequate material, suggested that supernumerary nipples are commonly associated with various other symptoms of developmental retardation and with symptoms of mental instability (neurasthenia, hysteria, neurosis, etc.).

There is excellent experimental evidence for the trophic rôle which nerves play in development (Hamburger(17, 18)); there is also ample proof for the manifold trophic functions of the brain (cf. Best and Taylor(6)), but we lack convincing experimental data which would justify the conclusion that the removal or lessening of trophic influences coming from one or the other region of the central nervous system has morphogenetic effects on development. Tsang(39), working with an inbred strain of polydactylous mice in which the abnormality usually affects the right, but sometimes the left hind foot, found as a frequent occurrence in the homolateral ventral horns of the lumbosacral region of the spinal cord an hypertrophy of the ventrodorsolateral cells. He believes that this hypertrophy in the spinal column is primary, and that it plays a causative rôle in the appearance of the unilateral polydactyly. It is of interest also that in this material sex acts as a modifier, the condition being more common in females than in males. However, Hamburger(18a) has pointed out already that it is unlikely that Tsang's interpretation of the developmental origin of mouse polydactyly is correct.

Until further evidence or other information is forthcoming the explanation of the origin and of the peculiar features of asymmetrical occurrence of supernumerary nipples and other abnormalities must remain doubtful. In particular, it cannot be decided if the asymmetric

occurrence of structural abnormalities, the type of handedness, and, in some instances, existing mental disturbances are caused by lateral functional differentiation within the central nervous system, or, if all of these features trace back to other factors in early development.

SUMMARY

The following conclusions can be drawn from the evidence which has been presented:

1. Supernumerary nipples are more common in men than in women. They occur more frequently on the left side of the body than on the right. With regard to incidence on the two body sides females show a more striking deviation from chance distribution than do males. The frequency of left-handedness, and of familial left-handedness, is higher among persons with supernumerary nipples than in the general population.

2. Congenital hemihypertrophy occurs much more frequently on the right side than on the left. The data suggest, but do not prove, an increased incidence of left-handedness among persons with this abnormality.

3. Congenital hemiatrophy is found much more commonly on the left side of the body than on the right.

The significance of these findings is discussed in the light of the observations of other investigators.

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THE VARIABILITY OF THE PERCENTAGE INDEX OF BUILD AS APPLIED TO THE PREDICTION OF NORMAL WEIGHT

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IN 1936 the Iowa Child Welfare Research Station published the first volume of the series *Appraising Physical Status* (1). In this volume McCloy discussed the problem of determining normal weight for any given body build as contrasted with the older technique of determining normal weight from an age-height-weight table. McCloy presented and defended the thesis that age-height-weight norms were unfair standards for many children because they represented only the average weight for children of a given age and height and had no reference to the individual differences in body build. According to such standards, the slight, linear, asthenic type of child would usually be underweight, while the stocky, lateral, pyknic type would commonly be too heavy. This is obviously unfair to the child, for the linear child frequently has a much smaller skeletal framework as the basis for his weight, and to attain the average weight for children of his age and height he would need to put on either a considerable quantity of subcutaneous tissue or a great amount of muscle. Conversely, the lateral child uses up too large a proportion of his assigned body weight in bony structure, and to attain his assigned weight, would have to reduce the amount of fat and muscle to markedly less than the average for children of his age and height.

After experimenting with upwards of thirty measurements, McCloy selected as the basis for his prediction of "normal weight for body build" four measurements of bony framework: standing height, circumference of chest at the level of the xiphoid cartilage (corrected for positive or negative deviations from the average amount of fat), width of hips at the crests of the ilia (also corrected for fat), and

the width of the knee at the epicondyles of the femur. These four measurements give a fairly accurate representation of the gross form of the skeleton, and from them, by means of multiple regression equations, the normal weight of the individual for his particular body build can be predicted.*

With the introduction of this technique, the problem of over- or underweight as a factor in appraising the physical status of the child took on new significance, since over- and underweight could be interpreted in terms of deviations from "normal" weight for build rather than in terms of deviations from "average" weight for height. The value of such a technique in school physical examinations has been readily recognized, but the chief argument against its widespread acceptance has been that to measure each child every year is much too time consuming for the average school situation. Whether the value of such information about the child would not more than compensate for the time spent is an open question, but to meet such arguments, certain short cuts have been proposed, among them the use of the "Percentage Index of Build." (2, p. 108.)

The percentage index of build, as defined by McCloy, is the quotient of "normal" weight, as predicted by the McCloy method from four measurements, divided by the weight given in the Baldwin-Wood age-height-weight tables (3). This index gives the deviation of weight for build from weight for height, and indicates the position of the individual in the continuum of body builds. Thus a child of the slight, linear type would have an index below 1.00, perhaps even as low as .85 or .80, while the stocky, lateral child would have an index above 1.00, running in some instances as high as 1.40 or more.

It has been suggested that it might be possible to measure each child once in three years, and in the interim to use the percentage index or some similar device as a substitute for the complete measurement program. Since the percentage index represents a percentage of the average, it was proposed that in the intervening years the average

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* An example of such a regression equation would be (eight-year-old boys):
Normal Weight = .1607 Height + .4028 Hip Width + .6789 Chest Circumference + 2.1453 Knee Width — 60.2709
It should be noted that those measurements, which may be influenced by the amount of subcutaneous tissue (chest circumference and hip width), are "corrected so that they register true differences in skeletal framework before being used in the prediction equation.

weight for the child's height might be found on the age-height-weight table, and that this average multiplied by his percentage index might be taken as approximately the "normal" weight.

Such a proposal assumes that the body build of an individual, as expressed by the index in question, remains fairly constant from year to year, and that it remains constant within very narrow limits, since deviations of 3 or 4 per cent would be sufficient to make the plan of little value. While it has generally been assumed by anthropometrists and anthropologists that body build is largely inherited and changes little during the school years, objective evidence concerning the range of deviation has heretofore been lacking.

It is not the purpose of this study to attempt to investigate all the intricacies of the question of the persistence of anthropometric type. We shall attempt only to determine pragmatically whether or not the percentage index remains sufficiently constant from year to year to make it feasible to predict the normal weight of an individual from stature taken annually, and additional measurements taken one or two years previously.

THE DATA

From the files of the Iowa Child Welfare Research Station cases were selected of boys who had been measured for three consecutive years, at such times that no less than eleven months or more than thirteen months had elapsed between any two consecutive measurements. Overlapping age ranges were chosen so that the data could be arranged in five groups, representing ages six to eight, eight to ten, ten to twelve, twelve to fourteen, fourteen to sixteen, and sixteen to eighteen. This procedure was followed in order that no gaps between any two years might occur. From the thousands of measurement cards on file it was possible to secure only a relatively small number which met the conditions outlined above, and the study was carried on with the following numbers of cases:

Age, Years	*Cases*
6, 7, 8	39
8, 9, 10	34
10, 11, 12	20
12, 13, 14	21
14, 15, 16	36
16, 17, 18	15

While the number of cases in each group is smaller than might be desired, it is felt that the evidence secured from them is significant, since they were selected without bias from the great number of measurements which have been taken at the Station during the past years, and since each set of measurements was scrutinized very carefully and compared with the measurements taken three months earlier and three months later to be sure that there were no detectable errors in any of the measurements.

ANALYSIS OF THE DATA

All chest-circumference and hip-width measurements were corrected for deviations from average fat according to the procedure outlined by McCloy (2, p. 48-53). Using these corrected measurements, together with the standing height and the knee width, the normal weight for each subject for each year was determined by means of McCloy's regression equations (2, p. 134-188). The weight given on the Baldwin-Wood age-height-weight tables (3) was found for each subject for each year. From these two figures the percent-

TABLE 1

Variations in percentage index of build over a three-year period

PER CENT VARIATION	AGE GROUPS 6 to 8	8 to 10	10 to 12	12 to 14	14 to 16	16 to 18	TOTAL
0	..	1	..	..	1	1	3
1	3	3	1	..	2	..	9
2	8	6	4	3	2	3	26
3	4	5	8	6	10	4	37
4	8	10	..	6	9	5	38
5	3	3	4	..	3	1	14
6	7	2	..	3	3	..	15
7	2	..	..	1	3	1	7
8	1	1	2	..	..	..	4
9	1	1	..	..	1	..	3
10 to 21	2	2	1	1	3	..	9

MEAN = 4.3 MEDIAN = 3.7

age index was computed by dividing the McCloy "normal" weight by the Baldwin-Wood "average" weight. The three indices thus secured for each individual were tabulated, and the amount of variation in the indices for each subject over the three-year period was determined. A summary of these variations will be found in Table 1.

It will be noted that the range of these variations is great, from 0 to 21, with 90.3 per cent of the cases falling within the span of 0 to 7, and 86.1 per cent falling within 0 to 6 range. While slight errors of measurement (which are present even in the best working conditions) might account for some of the variations, the fact that the average variation of the whole distribution is 4.3, and that the mediation variation is 3.7, would lead us to believe that a real change in the percentage index may take place during a period of three years. Furthermore, while slight errors of measurement may be artifacts in the true picture of constancy of body build, still they will be present in any working situation, and will have to be considered in determining whether or not any short-cut plan such as the one under consideration would be feasible.

The data were next rearranged in overlapping two-year intervals to determine whether or not the variation over such a short period

TABLE 2

Variations in percentage index of build over a two-year period

PER CENT VARIATION	AGE GROUPS 6 to 7	7 to 8	8 to 9	9 to 10	10 to 11	11 to 12	12 to 13	13 to 14	14 to 15	15 to 16	16 to 17	17 to 18	TOTAL
0	5	6	7	4	3	..	2	4	8	4	1	2	46
1	8	10	11	7	5	7	5	6	8	6	4	7	84
2	9	8	3	9	3	6	2	5	5	7	4	4	65
3	6	5	3	4	5	4	3	3	7	10	5	1	56
4	5	3	7	7	1	1	5	1	3	7	1	..	41
5	2	5	1	1	2	1	1	..	3	1	..	1	18
6	1	1	2	..	..	..	..	1	1	..	..	..	6
7	3	..	..	1	1	..	1	..	..	..	..	..	6
8 to 14	..	1	..	1	..	1	2	1	1	1	..	..	8

MEAN = 2.43 MEDIAN = 2.34

might be sufficiently small to permit of taking full measurements every other year. These variations were tabulated as before, and the results are shown in Table 2.

It will be noted that the range of variation is now reduced to 0 to 14, with 93.9 per cent of the cases falling within the range of 0 to 5, and 88.5 per cent falling within the range of 0 to 4. The mean variation over two years is 2.43, and the median variation is 2.34.

Thus it would seem that in the vast majority of cases we would be reasonably accurate in using the results of one set of measurements over a period of two years, and would not, on the average, miss our prediction by more than 2.43 per cent. But we must also note that with the subjects here used, we would miss the normal weight of 11.5 per cent of them by from 5 to 14 per cent.

To throw a little more light on these variations in the percentage index, the records of forty-three subjects whose measurements appeared in two adjacent age groups were studied. Thus, for a boy whose measurements had been used at 6, 7, and 8, and again at 8, 9, and 10, five consecutive measurements were available. If the variations in the percentage index were due only to errors of measurement, we would expect to find that the average change over a five-year period would be not appreciably greater than that over a corresponding three-year period. The indices were compared for the five-year period and the variations noted. These are shown below.

Extent of Variation in Percentage Index

Variation	Cases	Variation	Cases
0	0	8	3
1	0	9	2
2	1	10	2
3	2	11 to	
4	7	17	6
5	8		
6	8	Mean = 6.9	
7	4	Median = 5.44	

While the range, 2 to 17, is smaller than that for the three-year period, it is larger than that for the two-year period. Since the number of cases is small, this is probably due to selection. However, the mean variation, 6.9, and the median, 5.44, are significantly greater for

the five-year period, which would tend to indicate that a real change in the percentage index may take place. It was further noted that except in those cases where the variations fluctuated between 2 or 3 per cent, there was a noticeable trend either toward an increased or a decreased percentage index over the five-year period, indicating that the variation in the index was not due to chance errors of measurement but to some consistent change that was taking place.

A more detailed investigation was made of a number of the long term cases in an attempt to study these changes further. Graphs were made of the average height, chest circumference, hip width, and knee width of boys from birth to eighteen years of age, based on means reported by Meredith (4). The data for the long term cases were supplemented by additional measurements taken at three- and six-month intervals where these were available. The series of measurements for each dimension for each subject was then plotted on a graph with the average growth curve for that measurement. While the measurements for any given subject might be smaller or larger than the average, it would be expected that each dimension would maintain a fairly constant relationship to the average values, and that the curve of the individual would maintain the same form as the corresponding mean curve, as long as the individual was growing proportionately in all dimensions. For subjects whose percentage index was fairly constant, this was found to be true, but in cases in which the index changed markedly, it was noted that in one or more dimensions the individual curve would diverge markedly from the expected path. The effect of these divergences in some cases was quite evident. Occasionally the height increased much more rapidly than the other dimensions with the effect that the percentage index decreased steadily. In other cases the divergences seemed to be too slight to account for the changes in the index, and in still other cases all four dimensions would show divergences, some increasing and some decreasing, so that it was evident that they were changing disproportionately, but difficult to say just what the disproportion was. To determine the cause or causes of these changes is far beyond the scope of this study, but it is interesting to note that apparently they do occur, and that their occurrence must inevitably militate against the accuracy of any short-cut device for predicting normal weight from measurements taken at an earlier date.

In an attempt to clarify the confusing picture presented by these individual studies, an "average" boy was postulated for each age. The measurements for this "average" child were taken as the means of 120 to 150 cases for each age for each of the measurements used in the McCloy prediction. From these means the weight for each "average" boy was predicted. Using the mean heights for each age, the weight as given in the Baldwin-Wood tables was found, and the percentage indices were computed. These indices will be found in Table 3.

TABLE 3

Percentages indices for theoretical "average" boy

AGE, YEARS	HEIGHT	MCCLOY NORMAL WEIGHT	BALDWIN-WOOD WEIGHT	BODY BUILD INDEX
6	118.68	22.279	21.9	1.017
7	124.20	24.735	23.8	1.039
8	130.66	28.034	27.4	1.023
9	134.84	30.382	29.4	1.033
10	139.57	33.596	32.2	1.043
11	143.28	35.368	34.2	1.034
12	148.10	37.597	37.6	1.000
13	155.40	43.941	42.7	1.029
14	162.60	50.935	49.6	1.027
15	166.60	54.671	54.0	1.012
16	171.79	59.833	58.5	1.023
17	173.86	64.071	62.7	1.022

It will be noted that the percentage index of the "average" child ranges from 1.000 to 1.043. This variation cannot be attributed to any deviation from the average growth curves for the various dimensions or to any errors in individual measurements. Hence, it would seem to be due to an inherent incompatability of the two techniques, which may be slight, but for the purpose of this study is significant.

This apparent incompatability of the McCloy and the Baldwin-Wood norms led us to make one further approach to the problem, using an index which did not depend upon the Baldwin-Wood tables as a basis for predicting weight from measurements taken two or

three years previously. We chose the normal ponderal index, which is defined by McCloy as $\frac{(\text{Normal Weight})^{1/3}}{\text{Height}}$. Ponderal indices were computed for each subject for each year, and T-score values were assigned to them from tables presented by McCloy (2, p. 15).* As with the percentage index, it was not the actual value of the T-score in which we were interested, but in the variations shown from year to year. These variations were tabulated as before, and will be found in Table 4.

TABLE 4

Variations in the ponderal index T-scores over a three-year period

T-SCORES VARIATION	AGE GROUPS 6 to 8	8 to 10	10 to 12	12 to 14	14 to 16	16 to 18	TOTAL
0	1	1	..	..	..	..	2
1	6	5	6	2	2	..	21
2	6	10	7	6	5	1	35
3	4	7	4	2	10	1	28
4	5	3	1	2	4	5	20
5	2	2	1	5	5	6	21
6	5	2	..	..	3	2	12
7	2	1	..	2	1	..	6
8	4	2	1	..	2	..	9
9	..	..	..	..	1	..	1
10	1	..	..	..	1	..	2
11	1	1	..	..	2	..	4
12	..	..	..	1	..	..	1
13	1	..	..	..	..	..	1
14	1	..	..	..	..	..	1
21	..	..	..	1	..	..	1

MEAN = 4.12 MEDIAN = 3.38

* These tables give T-scores for the normal ponderal index for each year of age. By using the T-score value rather than the ponderal index itself, it is possible to make comparisons in terms of deviations from the averages for the given ages.

The variations in the ponderal index T-scores show a range of 0 to 21 over the three-year period, with a mean variation of 4.12 and a median of 3.35, 93 per cent of the cases lying within the range of 0 to 8. It should be remembered that our unit of variation is the T-score, representing tenths of a standard deviation, so that our mean variation is only .43 of a standard deviation, which is not great. But again we must stress the fact that we are not dealing with averages in the measurement program, but with individuals, which gives a new emphasis to the fact that the range is from 0 to 2.1 standard deviations.

TABLE 5

Variations in the ponderal index T-scores over a two-year period

T-SCORES VARIATION	AGE GROUPS 6 to 7	7 to 8	8 to 9	9 to 10	10 to 11	11 to 12	12 to 13	13 to 14	14 to 15	15 to 16	16 to 17	17 to 18	TOTAL
0	4	9	4	13	8	3	1	3	1	7	1	2	56
1	11	10	9	9	8	8	9	5	8	7	1	7	92
2	6	8	12	2	2	4	1	5	8	8	..	2	58
3	3	3	1	5	1	4	4	1	11	4	3	2	42
4	1	2	4	3	1	1	..	5	3	4	5	1	30
5	9	2	3	2	..	..	3	1	2	3	5	1	31
6	2	2	1	..	..	..	..	1	1	1	..	..	8
7	1	2	..	..	..	..	1	..	1	..	..	..	5
8	1	..	..	..	..	..	1	..	1	..	..	..	3
9	1	1	..	..	..	..	..	..	..	..	..	..	2
10	..	..	..	..	..	..	..	..	..	1	..	..	1
15	..	..	..	..	..	..	1	..	..	..	..	..	1

MEAN = 2.33 MEDIAN = 1.79

To complete the picture, variations in the ponderal index T-scores over a period of two years were also tabulated. These will be found in Table 5.

These variations show a range of 0 to 15, having a mean of 2.33 and a median of 1.79, with 93.6 per cent of the cases lying within a range of 0 to 5. Again we are forced to conclude that while the normal ponderal index varies but little from year to year on the average, still

individual variations do occur, and in some cases this variation is very great.

CONCLUSIONS

The question was raised as to whether or not the measurement program suggested by McCloy for the determination of normal weight might be administered at three-year intervals, using the percentage index of build, as defined by McCloy, as a substitute for the full program in the intervening years. On the basis of the evidence presented, the following conclusions seem justified:

Variations in the percentage index of an individual over a three-year period may be sufficiently great to introduce a significant degree of error into any calculations based upon them, this error in the case of normal weight varying from 0 to 21 per cent, and varying on the average 4.3 per cent. Since a negative variation of 4 per cent or more in the body weight of a child is considered to indicate "underweight," and such a variation might not be detected by the suggested technique, it is felt that the use of this technique is not justifiable.

Variations in the percentage index over a two-year period are less than over a three-year period, but still introduce error into any calculations based upon them. This error in the case of the normal weight varies from 0 to 14 per cent, with an average variation of 2.43 per cent.

The use of the T-scores of normal ponderal indices showed a similar variation in the normal ponderal index from year to year. The variation is small on the average, but marked in extreme cases.

It is therefore suggested that in school situations *where it is impossible to obtain full measurements on each child every year,* that the children be measured on alternate years, and that the percentage index* be used as a substitute during the intervening year, with the proviso that any child who is found to be more than 3 per cent underweight or 10 per cent overweight according to these figures be measured fully, and his normal weight computed from the new measurements. This may be unfair in some cases, but it will be an improvement over the

* Since no appreciable difference is found between the use of the percentage index and the normal ponderal index for the purpose suggested, the percentage index is here given as the chosen method, since the computation of it is much simpler.

use of the age-height-weight table, which is unfair to all except the "average" child. However, in school situations where complete measurements may be taken every year, the increase in accuracy will more than compensate for the additional time required.

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STATISTICAL CONTRIBUTIONS FROM THE MENTAL HYGIENE STUDY OF THE EASTERN HEALTH DISTRICT OF BALTIMORE

IV. FURTHER STUDIES ON PERSONALITY DISORDER IN THE EASTERN HEALTH DISTRICT IN 1933

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INTRODUCTION

THE preceding paper (1) of this series reported the first "epidemiological" studies of personality disorder in the Eastern Health District. A number of relationships between the occurrence of such disorders and certain geographic, biological, social and economic features of the district were described. In the present paper these studies are continued to include some further details in the analysis of the association of personality disorder with these factors. It concerns the same group of cases as those discussed in Paper III.

Personality disorder is defined for the purposes of these studies as recognizable inadequacy in capacity for personal and social adjustment, of such a kind as to indicate a need for psychiatric treatment, special education, social agency case work, or custodial care. A total of 1310 such cases were found active in the population in the calendar year 1933, of which 1077 (82.2 per cent) were identified with individuals or families enumerated in the census of the district taken in 1933. The present analyses are concerned only with these identified cases, since it is with the relations of cases to such factors as are reported by the census that the investigation is concerned.

The relationships discovered in the earlier studies are as follows: 1. Males have a higher rate than females, Negroes have a higher rate than whites, and of the two principal subdivisions of the district

Ward 6 has a higher rate than Ward 7. 2. Within each ward the white rate is highest in the areas with the largest proportion of Negroes. 3. The age specific rates of the whites show a sharp peak in the age group 10-14, and a smaller peak around age 40. This is seen in both wards, but the Ward 6 rate is higher than that of Ward 7 in every age group. 4. Jews have a much higher rate than non-Jewish whites. Both groups show the geographic pattern in rate differences of total whites: higher rates in Ward 6 than in Ward 7, and higher rates in Negro neighborhoods. 5. The white rate increases as the number of individuals in the family increases and as both the economic rating and housekeeping rating of the household decrease. In every grade of each of these characteristics the difference between the two wards persists.

At the time of writing the preceding paper, the only data at hand on the Jewish population were their numbers and geographical distribution. Since then the main facts of their demography and household situation have been put on punched cards, thus facilitating their differentiation from the rest of the white population in regard to all the characteristics studied.

TABLE 1

Cases of personality disorder and rate per 1000 among non-Jewish whites and Jews, by sex, for the district as a whole and by ward

		CASES		RATE	
		Non-Jews	Jews	Non-Jews	Jews
E.H.D.	Males	333	117	18.05	39.80
	Females	234	101	12.22	34.52
	Total	567	218	15.08	37.16
Ward 6	Males	194	106	22.30	42.74
	Females	150	90	16.54	36.79
	Total	344	196	19.36	39.79
Ward 7	Males	139	11	14.26	23.91
	Females	84	11	8.33	22.92
	Total	223	22	11.25	23.40

ANALYSIS OF WHITE RATES BY AGE, SEX AND WARD

There were found to be 5866 Jews in the Eastern Health District in 1933*. They comprise 10.5 per cent of the total population and 13.5 per cent of the white population. Table I presents the cases of personality disorder among non-Jewish whites and Jews, and the rate per 1000 of the corresponding population of all ages, by sex, for the whole district, and for each ward. The relations summarized in the introduction, regarding these factors, are seen here.

TABLE 2

Percentage distribution by five-year age groups of total population of non-Jewish whites and Jews

AGE GROUP	PER CENT OF TOTAL POPULATION	
	Non-Jews	Jews
0-4	7.1	5.6
5-9	9.0	7.9
10-14	10.3	11.0
15-19	9.7	12.1
20-24	8.9	13.8
25-29	8.5	8.7
30-34	7.6	6.0
35-39	7.8	6.7
40-44	7.3	7.1
45-49	6.3	6.0
50-54	5.2	5.0
55-59	3.7	3.9
60-64	3.3	2.3
65 and over	5.3	3.9
Total	100.0	100.0

The age compositions of these two groups, non-Jewish whites and Jews, are very different. Table 2 and Fig. 1 show the percentage distribution by five-year age groups of the two populations. Both show the effects of past immigration and a fall in birth rate, but in the Jews these changes have been extreme. This great dissimilarity in age

* See Reference 1, p. 119, for method of appraising the Jewish population.

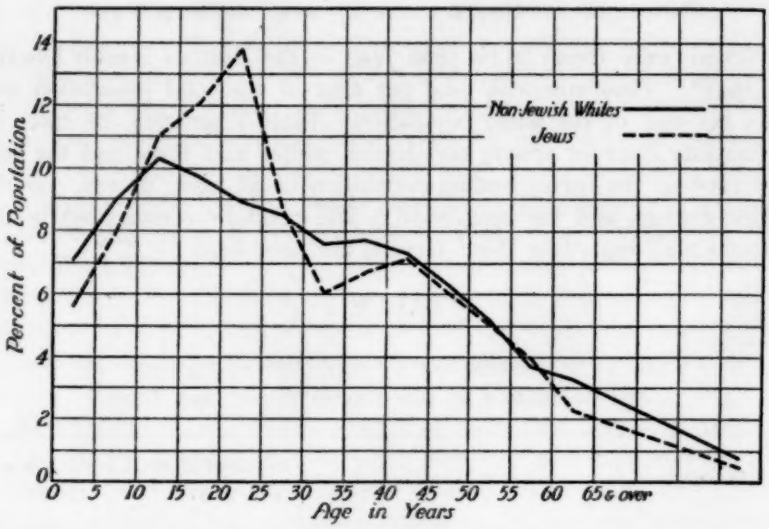

FIG. 1. PERCENTAGE DISTRIBUTION BY FIVE-YEAR AGE GROUPS OF TOTAL POPULATION OF NON-JEWISH WHITES AND JEWS

composition, however, accounts for none of the difference in rate between the two groups. The age corrected rate for non-Jews is 15.09 and for Jews 36.31; both are of the same magnitude as the crude rates. The cases and rates by ages are given in Table 3. Although the Jewish rates exceed those of the non-Jews at all ages, the excess in the ages below 15 years is slight and not significant. In the ages 15 years and over the differences are very large and are all significant, except at 65 years and over where Jewish cases and population are very few in number.

It is not clear whether the higher rate of Jews as compared with non-Jews is due altogether to a greater propensity for showing personality disorder. Experience with the practices and the recorded material of the study's various sources of data indicate that among the social agencies, which contribute a large proportion of these cases, the single agency which alone handles all adult Jewish cases may have an appreciably greater primary interest in personality problems than the agencies caring for non-Jews. A possible result of this is that case discovery is more complete among Jews than non-Jews, which if true, would result in a relatively more frequent appearance of Jews even in other sources than

TABLE 3

Cases of personality disorder and rate per 1000 among non-Jewish whites and Jews, by age groups

AGE GROUP	CASES		RATE	
	Non-Jews	Jews	Non-Jews	Jews
0-4	9	3	3.35	9.20
5-9	56	8	16.46	17.28
10-14	149	28	38.42	43.41
15-19	59	29	16.19	40.96
20-24	33	25	9.90	30.90
25-34	82	32	13.49	37.17
35-44	91	47	16.08	57.88
45-54	50	35	11.65	53.68
55-64	25	9	9.49	24.79
65 and over	13	2	6.53	8.81
Total	567	218	15.08	37.16
Age corrected rate*			15.09	36.31

* Total white population used as standard.

social agencies, since the activities of all types of sources are to some extent interrelated.

It has not been possible with the data at hand to devise any method by which this question, of whether Jews have a higher rate because of a greater proneness to personality difficulties or because they are better reported, may be answered in a convincing way. There are, however, some indications that more efficient case finding at least plays a part in determining the relatively high rate among Jews. Until this matter is better understood, the significance of the relative size of the Jewish rate will be left as an open question.

Of greater immediate interest are the relations of cases to certain factors within each of the two groups of whites. The non-Jewish whites are particularly important in the study of these relations, since they make up a large group that is somewhat more homogeneous than the total whites. At the same time the most clear-cut and interesting difference which has appeared in these analyses—that between the two

TABLE 4

Cases of personality disorder and rate per 1000 among non-Jewish whites, by sex and age

AGE GROUP	CASES		RATE		
	Males	Females	Males	Females	Difference
0-4.....	5	4	3.74	2.96	0.80
5-9.....	34	22	19.59	13.21	6.38
10-14.....	110	39	56.32	20.26	36.06
15-19.....	31	28	17.41	15.02	2.39
20-24.....	21	12	12.74	7.13	5.61
25-34.....	39	43	13.18	13.79	—0.61
35-44.....	44	47	15.51	16.65	—1.14
45-54.....	26	24	12.40	10.93	1.47
55-64.....	14	11	11.23	7.93	3.30
65 and over.....	9	4	10.51	3.52	6.99
Total.....	333	234	18.05	12.22	5.83

wards—shows up most strikingly in this group. The case rate for non-Jewish whites is 19.36 ± 0.91 in Ward 6 and 11.25 ± 0.86 in Ward 7 (Table 1). The difference is 8.11 ± 1.25.

As in total whites the male rate exceeds the female rate in non-Jews. The former is 18.05 ± 0.98 and the latter 12.22 ± 0.79, the

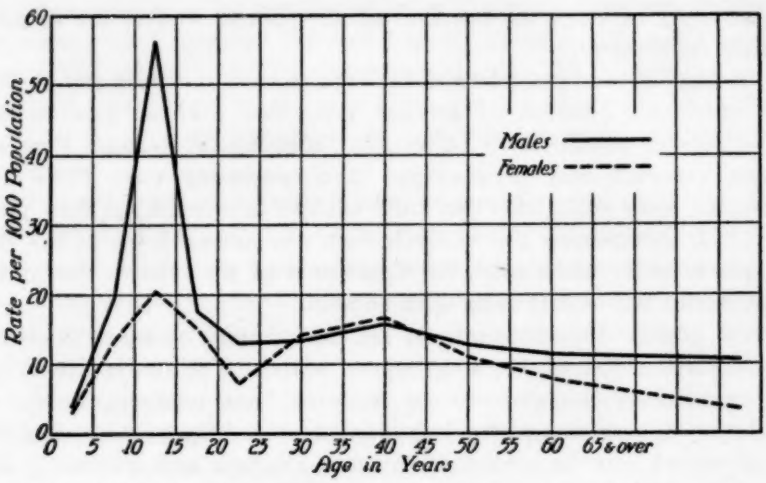

FIG. 2. MALE AND FEMALE CASE RATE IN NON-JEWISH WHITES, BY AGE

TABLE 5

Cases of personality disorder and rate per 1000 among non-Jewish whites by ward and age

AGE GROUP	CASES		RATE	
	Ward 6	Ward 7	Ward 6	Ward 7
0-4	7	2	5.34	1.45
5-9	38	18	22.37	10.57
10-14	86	63	45.22	31.88
15-19	36	23	21.60	11.63
20-24	19	14	12.36	7.80
25-34	47	35	16.48	10.85
35-44	59	32	22.36	10.59
45-54	29	21	14.52	9.15
55-64	14	11	11.45	7.79
65 and over	9	4	9.51	3.83
Total	344	223	19.25	11.21

difference being 5.83 ± 1.26. The age specific rates by sex are given in Table 4 and Fig. 2. Most of the male excess is in the age-group 10-14 years, which shows the only difference that is significant. It is accounted for largely by male juvenile delinquency.

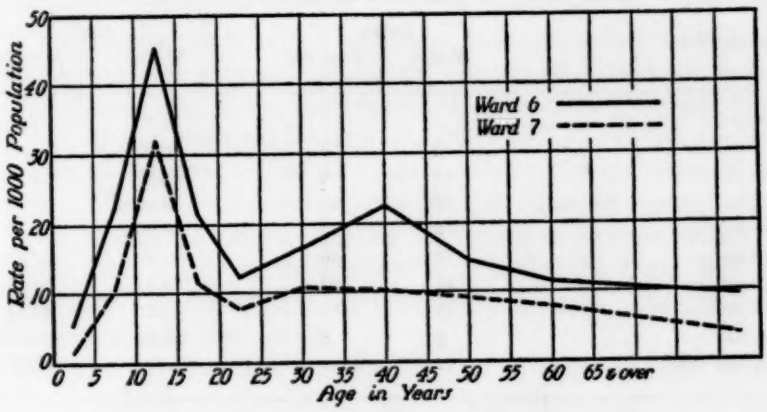

FIG. 3. CASE RATE IN NON-JEWISH WHITES, BY WARD AND AGE

Table 5 and Fig. 3 give the age specific rates by ward. The excess of Ward 6 rate over Ward 7 appears in every age group. The sex differences within each ward are essentially the same as those for the whole district, shown in Fig. 2, so that they need not be tabulated here.

The age specific rates in general show two peaks, a very pronounced one in the age group 10-14, and a smaller elevation around the age of forty. The implications of such age differences are not necessarily of fundamental clinical significance. The circumstances, both social and personal, associated with bringing the personality difficulties of children to attention are usually very different from those operating in the case of adults, so that in these studies age differences in prevalence need not indicate variability with age of innate adjustment capacity during individual development. Epidemiologically, however, such differences are of great importance, and it is only from this point of view that they are discussed here.

The age distribution of Jewish rates shows in general the same pattern as that of the non-Jews, except that the peak in the age group 10-14 is absent in Jewish females, and the elevation at middle age is relatively very much greater in both sexes. These relations are shown

TABLE 6

Cases of personality disorder and rate per 1000 among Jews, by sex and age

AGE GROUP	CASES		RATE	
	Males	Females	Males	Females
0-4	2	1	12.58	5.99
5-9	7	1	29.66	4.41
10-14	22	6	63.77	20.00
15-19	18	11	50.00	31.61
20-24	12	13	30.30	31.48
25-34	12	20	27.27	47.51
35-44	21	26	54.12	61.32
45-54	18	17	55.21	52.15
55-64	5	4	29.24	20.83
65 and over	..	2	....	18.52
Total	117	101	39.80	34.52

in the rates of Table 6 and in Fig. 4. The question of ward differences in respect to age cannot be studied in the Jews, since the Jewish population and case frequency of Ward 7 are too small to give reliable age specific rates.

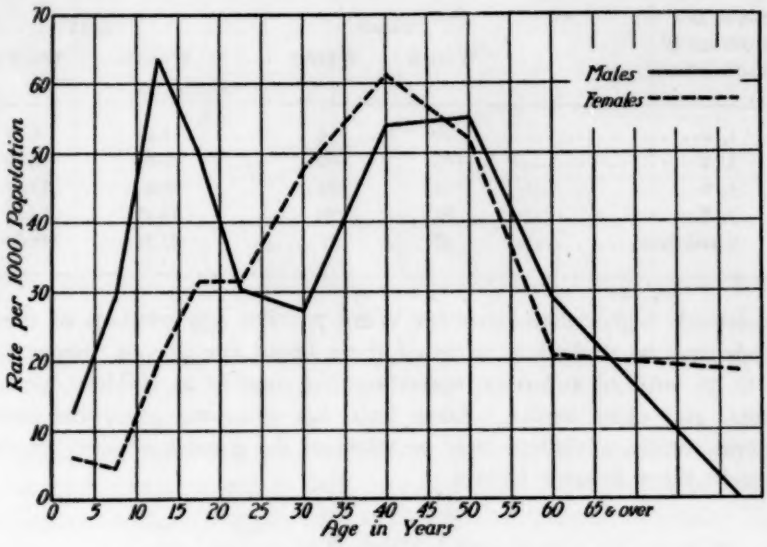

FIG. 4. MALE AND FEMALE CASE RATE IN JEWS, BY AGE

ANALYSIS OF WHITE RATES BY HOUSEHOLD CHARACTERISTICS

In the preceding paper (1) it was shown that among total whites the personality disorder rate increases as the number of individuals in the household increases. In the Eastern Health District the great majority of households are biological families, i.e., those with all members in the same line of descent, so that in general a household corresponds to a family. The possibility was pointed out that since the highest rates are found among the younger ages, and that since an increase in family size takes place largely by the addition of children, this trend may be only a reflection of the existing age distribution of rates. The question will be examined in some detail.

The cases and rates for non-Jews, by size of household and ward, are given in Table 7. The increasing rate with increasing family size is seen to be quite regular in both wards, and the rates for Ward 6 are

TABLE 7

Cases of personality disorder and rate per 1000 among non-Jewish whites, by ward and size of household

NO. OF INDIVIDUALS IN HOUSEHOLD	CASES		RATE	
	Ward 6	Ward 7	Ward 6	Ward 7
1, 2	26	14	11.96	6.37
3, 4	105	69	16.89	9.26
5, 6	114	74	20.49	12.27
7, 8	61	39	25.17	14.45
9 and over	38	27	27.32	18.60

consistently higher than those for Ward 7. The age relations of these trends may be studied in terms of three broad age groups: under 15, 15 to 34, and 35 and over, corresponding roughly to children, young adults, and older adults. Since finer age grouping gives the same general results, advantage may be taken of the greater stability of the rates in these broader classes.

TABLE 8

Cases of personality disorder and rate per 1000 among non-Jewish whites, by broad age groups and size of household

NO. OF INDIVIDUALS IN HOUSEHOLD	AGE GROUP:	CASES			RATE		
		0-14	15-34	35 & over	0-14	15-34	35 & over
1, 2		1	11	28	17.54	8.70	9.18
3, 4		55	60	59	19.14	12.01	10.18
5, 6		74	58	56	19.50	14.30	14.95
7, 8		47	30	23	23.49	17.02	16.92
9 and over		37	15	13	29.77	15.37	20.83

Table 8 and Fig. 5 present the non-Jewish cases and rates, by size of family and age group, for the whole district. It is clear from these figures that all three age classes contribute about equally to the general

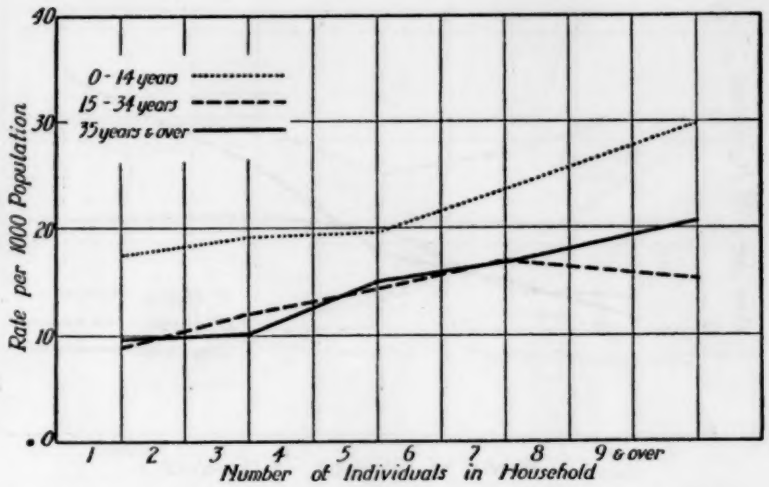

FIG. 5. CASE RATE IN NON-JEWISH WHITES BY BROAD AGE GROUP AND SIZE OF HOUSEHOLD, EASTERN HEALTH DISTRICT

increase in rate with larger families throughout the district. The youngest group shows, in each size-of-family class, its higher rate as compared with older groups, but it does not furnish an appreciably larger share of the general rise in rate with larger family size than the older groups.

TABLE 9

Personality disorder rate per 1000 among non-Jewish whites, by ward and broad age groups, by size of household

NO. OF INDIVIDUALS IN HOUSEHOLD	AGE GROUP:	WARD 6			WARD 7		
		0-14	15-34	35 & over	0-14	15-34	35 & over
1, 2		30.30	13.16	11.09	....	4.57	7.25
3, 4		26.76	13.65	14.61	12.43	10.65	6.57
5, 6		24.45	19.54	17.15	14.42	9.71	13.02
7, 8		28.98	20.41	25.60	18.36	13.98	9.54
9 and over		29.46	20.00	33.78	30.10	11.41	9.15

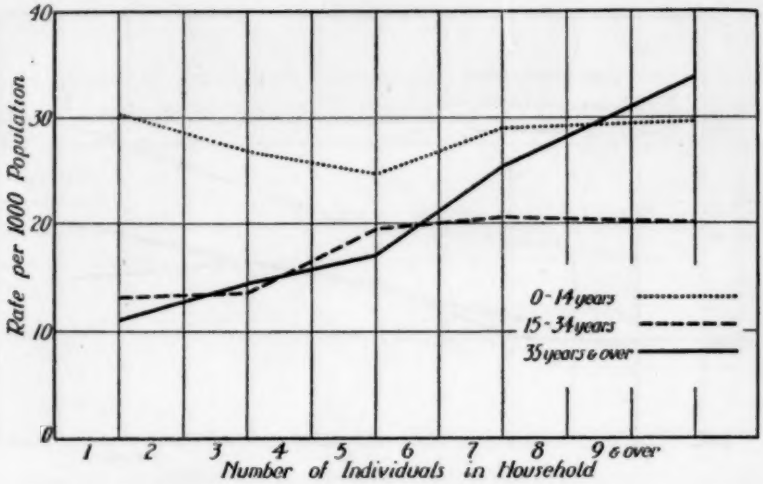

FIG. 6. CASE RATE IN NON-JEWISH WHITES BY BROAD AGE GROUP AND SIZE OF HOUSEHOLD, WARD 6

When these trends are analyzed by ward, however, a quite different set of relations appears. The rates by family size, age group, and ward are shown in Table 9 and Figs. 6 and 7. Looking first at those for Ward 6, it is seen that the youngest group is more or less uniformly high in all family size classes and thus contributes little to the trend in that ward. The young adults show a very slight rise. In the oldest group, however, the rate rises steeply. In Ward 7, on the other hand, the youngest ages show the most pronounced increase, the trend in the oldest age group being substantially horizontal. In this area the results are just opposite to what is seen in Ward 6.

A test of the validity of these conclusions is given in Table 10. Each of the distributions in Table 9 is compared, under the Chi-squared test, with the distribution expected on the assumption that the deviations of the rate in the several family size classes from the total rate of that age group are random. The test determines, in other words, the probability that chance would produce the observed trend if it were really horizontal and at the rate level of the whole group. The table gives, for each age group in either ward, the total cases, the total rate, and the value of χ^2 and P. The only distributions which deviate significantly

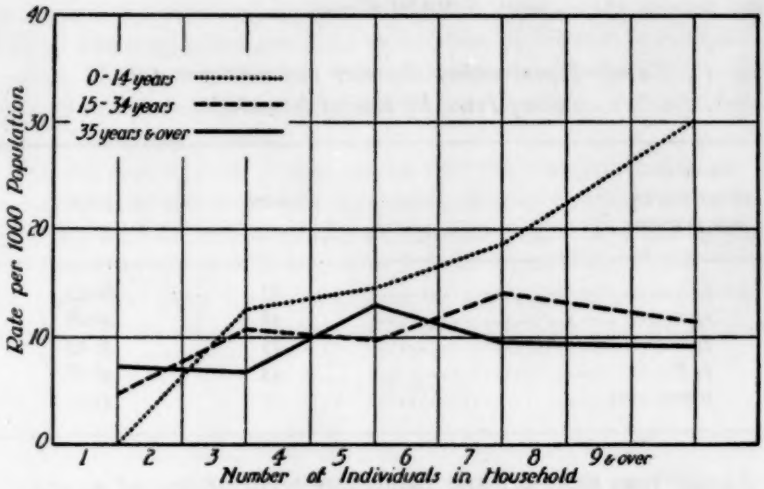

FIG. 7. CASE RATE IN NON-JEWISH WHITES BY BROAD AGE GROUP AND SIZE OF HOUSEHOLD, WARD 7

from the horizontal are those of the oldest age group in Ward 6, where P is .02, and the youngest in Ward 7, where P is .05.

Table 9 shows also that, with one exception, in every size of family, for each age group, the Ward 6 rate is higher than that of Ward 7. The single exception is in the youngest individuals of the largest families, where the rates for the two wards are almost equal.

TABLE 10

Values of χ^2 and P for test of deviation from horizontal of trend in rate with household size of Table 9, by ward and age group

(See text.)

AGE GROUP:	WARD 6			WARD 7		
	0-14	15-34	35 & over	0-14	15-34	35 & over
Cases	131	102	111	83	72	68
Total rate	26.67	16.84	16.31	16.41	10.29	8.75
χ^2	0.73	3.55	12.03	9.42	3.49	6.34
P	.95	.47	.02	.05	.48	.18

TABLE 11

Cases of personality disorder and rate per 1000 among Jews, by size of household

NO. OF INDIVIDUALS IN HOUSEHOLD	CASES	RATE
1, 2	23	60.53
3, 4	58	30.98
5, 6	75	33.44
7, 8	45	46.68
9 and over	17	41.77

Among Jews these age and family size relations are not so orderly. The cases and rates for all ages, by size of family, are given in Table 11. The smallest households have the highest rate, there is a large drop in the next size class, after which there is a small increase with increasing size. These rates are broken down into the three age groups in Table 12. The youngest ages have the highest rates in households with five to eight members, the young adults have a very high rate in the smallest house-

TABLE 12

Personality disorder rate per 1000 among Jews, by broad age group and size of household

NO. OF INDIVIDUALS IN HOUSEHOLD	AGE GROUP: 0-14	15-34	35 & over
1, 2	....	97.56	44.00
3, 4	20.78	28.22	40.29
5, 6	32.20	33.82	33.94
7, 8	35.86	37.28	73.93
9 and over	13.07	35.71	104.65
Total cases:	39	86	93

holds, and the older adults have very high rates in the largest households. The trends here are quite unlike those of the non-Jews, and in the absence of either comparable data or knowledge of the factors underlying these relations, examination of further details in the data does not seem advisable at present.

In the earlier study it was shown that the personality disorder rate in total whites increases with decreasing economic rating of the household and with decreasing quality of housekeeping.* The same relations are found in non-Jewish whites and Jews separately, Table 13 gives the cases and rates for these groups by grade of economic status and ward. The trends are all seen to be quite steep so that the association

TABLE 13

Cases of personality disorder and rate per 1000 among non-Jewish whites and Jews, by grade of economic status, by ward

	ECONOMIC STATUS	CASES		RATE	
		Ward 6	Ward 7	Ward 6	Ward 7
Non-Jews	A	80	74	8.67	6.67
	B	173	110	25.46	14.55
	C	89	37	58.63	36.71
	Unknown	2	2	....	....
Jews	A	55	11	21.62	18.71
	B	107	10	53.31	29.67
	C	34	1	100.89	71.43
	Unknown	..	..	....	....

of personality disorder with low economic rating is marked. In either group the trend is observed in both wards and the difference between the wards holds. (The Ward 7 Jewish rate in C households, based on one case, is of course dubious.)

Table 14 gives the corresponding data for housekeeping status. The general relations here are exactly the same as in the case of economic status, except for Jewish C households, where the Ward 7 rate is again quite unstable.

* The method of grading these factors is discussed in Reference 1, pp. 123 and 125.

TABLE 14

Cases of personality disorder and rate per 1000 among non-Jewish whites and Jews, by grade of housekeeping status, by ward

	HOUSEKEEPING STATUS	CASES		RATE	
		Ward 6	Ward 7	Ward 6	Ward 7
Non-Jews	A	157	141	12.28	9.22
	B	142	74	36.10	20.38
	C	37	5	64.01	23.70
	Unknown	8	3	....	....
Jews	A	84	13	28.40	18.44
	B	82	6	54.16	29.70
	C	27	3	105.88	272.27
	Unknown	3	..	....	....

TABLE 15

Total Negro cases of personality disorder, cases identified with census individuals or households, ratio of identified cases to total cases, and corresponding ratio among whites, by sex, for whole district, and by ward

		TOTAL CASES	IDENTIFIED WITH CENSUS INDIVIDUAL OR HOUSEHOLD	RATIO TO TOTAL CASES	WHITE RATIO
E.H.D.	Males	233	200	.86	.83
	Females	118	92	.78	.80
	Total	351	292	.83	.82
Ward 6	Males	95	82	.86	.83
	Females	40	28	.70	.80
	Total	135	110	.81	.81
Ward 7	Males	138	118	.86	.84
	Females	78	64	.82	.81
	Total	216	182	.84	.83

ANALYSIS OF NEGRO RATES

Detailed analysis of Negro personality disorder, beyond the statement of its prevalence by sex and ward, was not included in the earlier study. The relations that have so far been studied in this group will

be presented here. As in the whites the analysis will be confined to those cases identified with individuals or households enumerated in the census. The same proportion of cases (less than 20 per cent) are thus omitted as in the whites and this proportion holds with sufficient uniformity through the major groups within the race as not to affect comparisons among them. Table 15 presents the total cases, those identified with census individuals or households, and the ratio of the identified cases to the total, by ward and sex. The last column of the table shows the corresponding ratios for the whites, as given in Table 3 of Paper III. The Negro females of Ward 6 are slightly under-represented in comparison with the other groups, but only by about 5 cases.

The Negro cases and rates by age and sex are given in Table 16. These show the same general distribution as those of the whites, with. however, some interesting differences in details. In males the peak

TABLE 16

Cases of personality disorder and rate per 1000 among Negroes, by sex and age

AGE GROUP	CASES		RATE	
	Males	Females	Males	Females
0-4	..	2	....	2.85
5-9	19	6	27.66	8.28
10-14	93	24	155.52	38.40
15-19	28	14	64.52	24.48
20-24	9	5	16.88	7.38
25-34	22	17	18.49	12.12
35-44	16	15	16.65	15.94
45-54	7	6	13.89	12.02
55-64	1	1	4.88	5.18
65 and over	5	2	49.02	17.70
Total	200	92	33.89	14.26

in the age group 10-14 years is excessively high and in both sexes the middle age elevation is so slight as to be negligible. The rise in the oldest age group in both sexes represents too few cases to be worth particular note. The male excess is significant only in the ages 5-19.

TABLE 17

Cases of personality disorder and rate per 1000 among Negroes and percentage of Negroes in the population, by subdivision

SUBDIVISION	WARD 6 V	VI	VII	VIII
No. of cases	62	36	12	.....
Rate per 1000	25.92	25.35	37.27	.....
Per cent Negro	78.7	27.3	3.8	0.3
SUBDIVISION	**WARD 7 I**	**II**	**III**	**IV**
No. of cases	95	84	3	.....
Rate per 1000	21.48	23.62	15.96	.....
Per cent Negro	80.1	63.2	2.2	0.1

The geographical distribution of Negro rates is given in Table 17.* Paper III (1) presented a comparable study of whites (Table 5, p. 118), which showed the association of white personality disorder with Negro neighborhoods that was mentioned above. The Negroes are seen not to exhibit a similar association; their rates seem to bear no relation to the proportion of the population which they themselves represent. The differences between the two wards, by subdivision, are seen to

TABLE 18

Personality disorder rate per 1000 among Negroes, and percentage of Negroes in the population, by pairs of subdivisions from west to east

SUBDIVISION	I + V	II + VI	III + VII	IV + VIII
Rate per 1000	23.04	24.12	29.41	.....
Per cent Negro	79.6	45.9	3.0	0.2

* The arrangement of the subdivisions of Table 17 are shown in the map of the district given in Paper III (Figure 1, p. 113).

be slight (the rate in subdivision III, based on only three cases, is quite unstable). The general facts of the relation of Negro case rates to Negro neighborhoods are shown more concisely, and without loss of significant details, in Table 18, where adjoining subdivisions in different wards are combined to make larger areas differing conspicuously in their proportion of Negroes. The increase in rate with decreasing proportion of Negroes is not sufficiently marked to indicate a real trend. In any event, the opposite trend shown by whites is clearly not observed here.

The total Negro rate by ward is: 26.38 ± 2.35 for Ward 6 and 22.25 ± 1.68 for Ward 7. The difference of 4.13 ± 2.89 is quite small. However, when these rates are broken down by ages (Table 19) an additional fact appears. The excessively high rate in the age group 10-14

TABLE 19

Cases of personality disorder and rate per 1000 among Negroes, by ward and age

AGE GROUP	CASES		RATE	
	Ward 6	Ward 7	Ward 6	Ward 7
0-4	1	1	2.12	1.09
5-9	9	16	19.61	16.79
10-14	52	65	123.81	80.95
15-19	11	31	33.95	45.45
20-24	3	11	8.00	13.17
25-34	16	23	17.78	13.59
35-44	8	23	12.72	18.07
45-54	5	8	13.77	12.50
55-64	1	1	6.62	4.05
65 and over	4	3	51.95	21.74
Total	110	182	26.38	22.25

is seen in both wards, and in this age group alone the difference between the wards is very great and statistically significant. The difference here is 42.86 ± 17.71. For all other ages combined the Ward 6 rate is 15.47 and that of Ward 7, 15.86.

When these latter groupings are broken down by sex only the males of 10-14 show a conspicuous difference in rate in the two wards. Juvenile

delinquency accounts for the whole of this difference. The Negro male juvenile delinquency rate per 1000 in this group is 184.83 ± 24.95 in Ward 6 and 103.36 ± 18.42 in Ward 7, the difference being 81.47 ± 31.01.

It may be added that adult delinquency has played only an incidental part in determining the classification of personality disorder. The problem of delinquency for its own sake is not being considered in these studies. There are among the Negro cases only 17 adult delinquents, 15 males and 2 females, all of whom are classified as personality problems on the basis of other evidence. There are comparatively few female juvenile delinquents, only 15 among the Negro cases. The Negro male juvenile delinquents on the other hand, number 114, of whom 79 are in the age group 10-14. The total 114, who make up 39 per cent of all Negro cases, fall in the age group 5-15 years. Their rate is 118.90 ± 12.74 in Ward 6 and 64.73 ± 9.24 in Ward 7, with a difference of 54.17 ± 15.74. Omitting all male juvenile delinquents, the total Negro rate becomes 12.95 ± 1.84 in Ward 6 and 15.16 ± 1.32 in Ward 7, the difference being 2.21 ± 2.27.

TABLE 20

Cases of personality disorder and rate per 1000 among Negroes, by ward and size of household, and rate for whole district by size of household

NO. OF INDIVIDUALS IN HOUSEHOLD	CASES		RATE		
	Ward 6	Ward 7	Ward 6	Ward 7	E.H.D.
1, 2	10	6	15.43	7.60	11.13
3, 4	32	34	25.81	15.38	19.12
5, 6	22	62	23.33	27.76	26.45
7, 8	20	39	28.13	26.57	27.08
9 and over	26	41	41.40	27.72	31.08

In the relation of personality disorder to size of household, the Negroes show the same general facts as the whites. The rates by size of household and ward are given in Table 20. For the district as a whole (last column) the rates increase steadily as the size of the household increases. This is true also in each ward, although the trends there

TABLE 21

Cases of personality disorder and rate per 1000 among Negroes, by broad age group and size of household

NO. OF INDIVIDUALS IN HOUSEHOLD	CASES			RATE		
	0-14	15-34	35 & over	0-14	15-34	35 & over
1, 2	4	3	9	181.82	4.77	11.45
3, 4	35	17	14	46.79	11.24	11.75
5, 6	41	31	12	34.22	25.96	15.31
7, 8	23	24	12	23.02	30.89	29.78
9 and over	41	20	6	38.82	28.69	16.95

are less regular. Ward 6 rates are on the whole higher than those of Ward 7. The trends in broad age groups are given in Table 21. In general the youngest age group shows a decreasing rate as the household becomes larger, while the middle and oldest age groups tend to increase. Irregularities, however, appear in all three distributions. The same relations are seen in each ward, so that the rates by ward need not be presented.

TABLE 22

Cases of personality disorder and rate per 1000 among Negroes, by economic status and by housekeeping status of the household, by ward

		CASES		RATE	
		Ward 6	Ward 7	Ward 6	Ward 7
Economic Status	A	2	14	6.78	11.16
	B	48	94	21.65	19.31
	C	60	74	36.88	37.51
	Unknown	..	..	....	....
Housekeeping Status	A	10	70	11.76	19.30
	B	52	80	23.94	21.25
	C	44	31	41.98	45.66
	Unknown	4	1	....	....

The Negroes show also the same general relations as the whites in the association of personality disorder to economic and housekeeping status (Table 22). The rate increases with decreasing grade of both these characteristics in each ward.

DISCUSSION

The facts that stand out most clearly in the foregoing analyses are the marked geographical variation of personality disorder in the white population, the equally marked absence of such variation in the Negro population, and, more or less independently of these relationships, the tendency of personality disorder to be more frequent in large families and in households whose resources and living conditions are poor.

In considering the geographical pattern in whites two underlying sets of facts appear at present to bear most strongly on how it may be interpreted. The southern half of the district, Ward 6, shows a greater prevalence of white personality disorder than the northern half, Ward 7. At the same time the western part has a higher prevalence than the eastern part. This latter trend, however, has been shown to be somewhat subsidiary to the ward difference in that it shows up more strongly within wards than in the district as a whole, and likewise is much more pronounced in Ward 6 than in Ward 7. The underlying facts of interest here are first, that this trend follows in general the distribution of Negroes in the population, and second, that the Negroes themselves do not show the trend.

The indication that the presence of a large proportion of Negroes in the population is in some way related to the appearance of a greater frequency of personality disorder in whites might suggest some kind of variability of reaction on the part of whites in relation to changes in situational influences. However, the fact that the tendency of Negroes to show such disorders does not exhibit a corresponding trend seems opposed to this notion, unless it is assumed that the influences are associated with, say, inter-racial conflicts which somehow show their effects only in the whites.

Another possibility is that the observed relations of white disorders to Negro neighborhoods has been brought about passively, so to speak, in the course of local changes in racial composition of the population. If whites leave an area and Negroes move in, those whites who remain may be the less stable ones from the mental hygiene point of view. Such population changes have actually taken place in the Eastern Health

District. The Federal Census figures for 1910 and 1930 (the latter agree very closely with those of the 1933 district census) show that in the earlier year the Negroes made up 10.3 per cent of the population, whereas two decades later they had increased to 21.0 per cent with a corresponding decrease in the whites. In Ward 6 the change was from 10.1 to 15.2 per cent, and in Ward 7 from 10.4 to 26.4 per cent.

Returning to the difference between the two wards, the underlying facts to be considered are, first, the difference has no consistent relation to the proportion of Negroes in the population; second, the Negroes do not show the difference except in regard to male juvenile delinquency; third, it is not determined by differences in age composition, or differences in distribution of family size, economic status or housekeeping status; fourth, it appears in both non-Jewish whites and Jews.

It has not been possible to discover any reason for believing that the two wards are treated differently by the agencies and institutions whose records are the source of the study's material. On the other hand the evidence to be had from the material and its analysis indicates a very great improbability that the observed difference between the wards is in any way due to their being differently reported.

From the broadest point of view, the populations of the two wards may differ in their capacities for personal and social adjustment or the two wards may differ in their social, cultural, economic, or other influences in such a way as to produce differing amounts of personality disorder in their respective populations. These possibilities are not necessarily, of course, opposed alternatives. The problem is that of the relative rôles of constitutional differences on the one hand and differences in conditions on the other, when considered as interacting forces. In the Eastern Health District such measures of social and economic factors as are available, and have been examined in this analysis, show little difference in such factors between the two wards so far as the white population is concerned, and do not in any degree explain the diversity in prevalence of personality disorder. The particular factors studied, however, do not exhaust the possibilities of situational differences, so that a more complete answer to this phase of the problem must await more detailed information on these matters.

If diverse external influences play an important part in the ward difference in prevalence, it is interesting that Negroes do not show their effects except in the case of male juvenile delinquency. For all other

types of disorder, which make up the larger part of the cases, the Negroes show no difference in rate of disorder between the two wards. It is not clear whether the evidence justifies the hypothesis that only in regard to such external factors as affect the juvenile delinquency rate of Negroes do the two wards differ, and that it is these particular factors which play a part in determining the difference in white rate. White juvenile delinquency does not play a similar major rôle in that difference. There may be here an opportunity for clinical psychobiology to contribute to an understanding of some of these relations.

In regard to innate differences in the white populations of the two wards, it is known that the total white population of the district is composed of a number of different ethnic groups, but their numbers and distribution are for the most part as yet unknown. However, the Jews are perhaps the most distinct and most homogeneous of these several groups, and the fact that they show a difference in prevalence of personality disorder in the two wards appears to be a fact of some significance. Population changes may also play a part in this. The Jewish community of which Ward 6 (particularly its southern portion) is a part, is the area in which the immigrants coming in around the beginning of the present century first settled. It has since become an even poorer neighborhood, one from which Jews have tended to move when their circumstances permitted. Those who have remained may well be the less resourceful and perhaps the less stable of the original community.

The same argument may, of course, apply to non-Jewish whites in this area, though less is known about their movements in the past decades. These non-Jews consist mainly of a large group corresponding roughly to the descendants of earlier migrants of Northwestern European stock, and of more recently immigrated Italians, Czechs, and other Slavs. The only relevant fact known about any of these at present is that Ward 7 contains a large Czech colony. It is perhaps worth mentioning that this group has a local reputation for marked industry and stability.

The analysis of case rates in relation to household characteristics carry the observations discussed in the preceding paper of the series into finer details, without, however, changing the general nature of the relations found there. The rates increase as the size of the family increases, and as the rating of economic and housekeeping status decrease, in both non-Jewish whites and Jews, and in Negroes.

The most interesting new facts that have been presented here concern the age relations of the trend in rate with family size. It seems clear that this trend is by no means merely a consequence of the change in age distribution with increasing family size. In the non-Jewish whites, in whom the details can be best studied, children, young adults, and older adults all show the trend when the rates for the district as a whole are considered. The two wards, however, show a quite surprising difference in regard to this. In Ward 6, practically all of the increase is in the older adults only; the children show little increase but instead maintain a somewhat uniformly high rate through all the family-size classes. In Ward 7 these relations are just reversed. The older adults show a relatively low rate in all size classes, whereas the trend in children is a very steep and regular rise. In both wards the younger adults show a slight rise. No explanation of these contrasting relationships can be offered.

Among Jews the limited population size and number of cases in Ward 7 prevents studying this by ward. For the whole district the trends by age group are irregular, but only in the older adults is there indication of an increase in rate with increasing family size. In Negroes the age trends are also irregular but show still another set of relations. The rate tends to fall in children, to rise appreciably in younger adults, and to show on the whole little change in older adults. These relations remain substantially the same in each ward.

That the difference in prevalence between the wards among whites is independent of the observed association of personality disorder with the several social and economic factors that have been studied, is further demonstrated in the present analysis. The difference between the wards persists in every size of household and each grade of economic and housekeeping status in both non-Jewish whites and Jews.

One fact of major importance must be taken into consideration in regard to the demonstrated association of high rates of personality disorder with low economic status and poor housekeeping. Social agencies, whose clients are very largely families of the lower social-economic levels, are among the principal sources of material of this study, so that the cases are unquestionably selected for those characteristics that distinguish the recipients of social agency attention from the rest of the population.

The limitations thus imposed on the attempt to measure the complete prevalence of personality disorder are unavoidable. The definition of personality disorder here employed, however, seeks to emphasize that the cases studied are those in which the question of community responsibility is paramount. From this point of view, selection in the direction of social agency case material is by no means an artificial or undesirable element in the determination of the prevalence of such disorder.

At the same time the authors are fully aware of the necessity of evaluating its measurements of personality disorder in relation to the important factors that vary with social-economic class. All of the material so far studied, and presented in this series of papers, deals with the year 1933. A similar but more comprehensive survey for the year 1936 is now in process of analysis. Another, more detailed, census of the district for that year has also been prepared. With the new material many questions may be examined that could not be studied with the data of the first survey. Foremost among these are the problems of social-economic level. In addition, further knowledge of the ethnic composition of the white population has been obtained, and this will permit more complete analysis of many of the relations that have been presented here.

SUMMARY

1. Studies of the geographic, biological, social and economic relationships of personality disorder in the Eastern Health District in 1933, begun in the preceding paper of this series (1), are continued in this report. The general relations observed in the whole investigation will be summarized here.

2. Personality disorder is defined as recognizable inadequacy in capacity for personal and social adjustment, of such a kind as to indicate a need for psychiatric treatment, special education, social agency case work, or custodial care.

3. The two principal geographical divisions of the district, Ward 6 on the south and Ward 7 on the north, differ greatly in prevalence of personality disorder, Ward 6 showing the higher rate. In the white race this difference is found in both non-Jews and Jews, in all age

groups, in both sexes, in families of every size, in households of each grade of economic and housekeeping status, and in all the combinations of these characteristics in which sufficiently stable rates for making the comparison could be calculated. Among Negroes the ward difference is seen only in male juvenile delinquents.

4. Male rates exceed female rates only in the ages below 20 years, and most conspicuously in the age-group 10-14. It is due to the relatively high frequency of male juvenile delinquency.

5. The rate for Jews is very much higher than that for non-Jewish whites. The difference may be due to the better reporting of personality disorder in Jews, but this cannot be stated conclusively.

6. The rate for Negroes exceeds that for whites, but only in males, and here the difference is due largely to the great frequency of Negro male juvenile delinquents.

7. White rates tend to be highest in areas with the largest proportion of Negroes. Negro rates, on the other hand, do not show this trend in relation to their own relative numbers in the population. The trend in whites shows up more noticeably in each ward separately than in the district as a whole, and is most pronounced in Ward 6.

8. In both races, and among whites, in both non-Jews and Jews, the rate increases with increasing size of family. This trend is not due only to the change in age composition as the family size increases. In non-Jewish whites, where the age relations may be studied in some detail, the trend is shown almost entirely by older adults in Ward 6, and mainly by children in Ward 7.

9. In whites, both Jewish and non-Jewish, and in Negroes, the rate increases as both the economic status and quality of housekeeping decrease.

10. As a possible explanation of at least some of the observed geographical variations in prevalence of personality disorder, local population movements are suggested. Negroes have replaced whites, during the past decades, in the areas which the former now dominate. In the same period more attractive neighborhoods in other parts of the city have drawn Jews and perhaps other whites from an area that includes Ward 6. In either case the whites who have remained may be those who are more prone to show personality disorder.

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RACIAL AND REGIONAL DIFFERENCES IN STANDARD THERAPY RATES AMONG WHITE AND NEGRO MENTAL PATIENTS[1]

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THE present paper proposes to present certain data and to utilize certain procedures in the analysis of two presumably important social issues: (1) Are there significant *racial* differences in therapeutic results among white and Negro resident patients in the Georgia State Hospital and in the various State Hospitals of the United States? (2) Are there significant *regional* differences in therapeutic results among white and Negro resident patients in the Georgia State Hospital and in the various State Hospitals of the United States?

Utilizing ten separate clinical factors as bases of comparisons, the senior author, in a series of previous studies,[2] has reported a number of marked and statistically reliable racial and regional differences among seven clinical categories of white and Negro mental patients in Georgia and in the United States. The present study presents data supplementary to that previously reported.

PREVIOUS STUDIES

That the reader may better comprehend the relation of the present findings to certain of those previously reported, it seems advisable to

[1] A considerable portion of the data in this paper was presented before the Society for the Psychological Study of Social Issues, Forty-Sixth Annual Meeting of the American Psychological Association, Columbus, Ohio, September 7-10, 1938.

[2] Four of these studies have been previously reported, as follows: (a) Section I (Psychology), American Association for the Advancement of Science, Indianapolis, December 29, 1937; (b) Section on Research, Southern Sociological Society, Chattanooga, April 1, 1938; (c) Southern Society for Philosophy and Psychology, Knoxville, April 15, 1938; (d) Institute of Public Affairs, University of Georgia, July 15, 1938.

attempt a brief summarization of data, presented elsewhere, bearing on the three following questions: (1) What is the relative status of certain mental disorders among Georgia whites and Georgia Negroes? (2) What is the relative status of certain mental disorders in Georgia as compared with the United States as a whole? (3) How does Georgia compare with other states in adequacy of hospitalization facilities?

Data bearing on the first two of the above three questions were obtained from comparisons based on each of *ten* clinical factors and each of *seven* clinical categories of mental disorders. The seven clinical categories of disorders used as bases of racial and regional comparisons were: (1) senile psychoses; (2) psychoses with cerebral arteriosclerosis; (3) general paralysis; (4) psychoses with cerebral syphilis; (5) manic-depressive psychoses; (6) dementia praecox psychoses; (7) all clinical groups (i.e. all mental disorders of every type).

The ten clinical factors used as bases of the racial and regional comparisons were, in each instance, as follows:

1. Standard rates of first admission (i.e. number of first admissions per 100,000 general population fifteen years of age and over).
2. Standard death rates (i.e. number of deaths per hundred resident patients).
3. Standard discharge rates (i.e. number of discharges per hundred resident patients).
4. Standard readmission rates (i.e. number of readmissions per hundred discharges).
5. Median age at first admission.
6. Median duration of residence prior to death of patients dying during a period of hospital residence.
7. Median age at death of patients dying during a period of hospital residence.
8. Per cent of discharged patients classified as "recovered".
9. Per cent of discharged patients classified as "improved".
10. Per cent of discharged patients classified as "unimproved".

Georgia whites vs. Georgia Negroes comparisons, 1923-32[8]

The Negro-white comparisons based on the above ten clinical factors reveal many socially significant and statistically reliable differences.

[8] For a more detailed statement of findings resulting from these comparisons the interested reader is referred to the following sources: (a) J. E. Greene, Analyses

They indicate that, in Georgia, Negro mental patients have a generally unfavorable status as compared with white mental patients. Out of a total of 140 direct inter-racial comparisons, Negroes compare favorably with whites in only 49 instances. As compared with Georgia whites, Georgia Negroes have high hospitalization rates, notably high death rates and notably low discharge rates. Georgia Negroes are hospitalized at earlier ages, die during shorter periods of hospital residence, and die at much earlier ages than do Georgia whites. However, Georgia Negroes compare favorably with Georgia whites in having high percentages of discharged patients classified as "recovered" or "improved", and in having low percentages of discharged patients readmitted for further hospital treatment.

The apparent relative superiority of Negroes over whites in these two last-mentioned series of comparisons may be, and probably is, more apparent than real, since the very high death rates of Negroes tend to make discharged Negroes a more highly selected group as to therapeutic prognosis than are discharged whites. To the extent that discharged Negroes are actually a more highly selected group therapeutically than discharged whites the latter comparisons are only spuriously favorable to Negroes. Furthermore, as can be readily demonstrated, Georgia has a serious deficiency of hospitalization facilities. Under these circumstances it is reasonable to assume as a working hypothesis that in the competition for hospitalization facilities, Negroes may be discriminated against by County Ordinaries in first admission or readmission policies. The data at hand do not furnish reliable proof of the extent, if any, to which this condition exists.

Georgia vs. United States comparisons, 1923-32

Although the findings obtained from the Georgia vs. United States comparisons lend themselves to a variety of possible interpretations, it is clear that significant differences exist between Georgia and the United States with respect to each of the ten bases of comparisons herein employed. Out of a total of 70 direct comparisons, Georgia has an ap-

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of racial differences within seven clinical categories of white and Negro mental patients in the Georgia State Hospital, 1923-32. *Social Forces*, Vol. 17, No. 2, December, 1938, pp. 201-211. (b) J. E. Greene and J. L. Dupree. Sex differences in certain mental disorders among whites and Negroes in Georgia during the decade 1923-32. *The Journal of Psychology*, Vol. 7, 1939, pp. 201-209.

parently favorable status in 36 (or 51 per cent) of the instances. As compared with the United States, Georgia has notably low hospitalization rates, relatively low death rates, significantly high discharge rates and notably low readmission rates. Georgia patients are hospitalized at significantly earlier ages and die at much earlier ages than do United States patients. However, Georgia patients tend to have somewhat longer periods of hospital residence prior to death than do the control groups. Georgia compares unfavorably with the United States in having significantly smaller percentages of discharged patients classified as "recovered". However, Georgia patients are somewhat more likely than the control groups to be discharged as "improved" and only slightly less likely than the control groups to be discharged as "unimproved". It should be emphasized that 23 out of the 36 ratings favorable to Georgia were obtained from comparisons based on the four standard rates. It should also be noted that these comparisons are precisely the ones on which spuriously favorable ratings are most likely to occur. That is, presumably favorable ratings may result from seriously inadequate facilities for hospitalization and treatment rather than from a genuine lack of need for such hospitalization and treatment. In the same way, a presumably favorable status on standard readmission rates (i.e. few readmissions per 100 discharged patients) may be due to a highly "unfavorable" standard death rate in the hospital population which eliminated those persons who, had they been discharged, would have been poor readmission risks. Similarly, Georgia's relatively high discharge rate may be an index of overcrowded facilities rather than conclusive proof of more adequate therapy or of less malignant disease processes.

Adequacy of hospitalization facilities in Georgia, 1933

In our efforts to procure scientific data bearing on the two preceding questions, two tentative generalizations have been made. Firstly, it has been suggested that the apparently favorable status of Georgia Negroes in certain of the comparisons with Georgia whites may be due to a serious lack of adequate hospitalization facilities in Georgia, and that this lack of facilities may be operating to the disadvantage of the Negroes as compared with the whites. Secondly, it has been suggested that the presumably favorable status of Georgia mental patients in certain of the comparisons with the United States mental patients also may be due

to the inadequacy of hospitalization facilities in Georgia as compared with many other states.

Our present concern is to determine from valid objective evidence the extent to which Georgia compares unfavorably with other states in adequacy of hospitalization facilities for mental patients. To this end access is made to certain data computed by Ellen Winston and appearing in a recent issue of the American Sociological Review (April, 1938). Making use of data furnished by the United States Bureau of the Census, Winston computed, for each of the 48 states, four standard indices of adequacy of hospitalization facilities, as follows:

1. Capacity of State hospitals, 1933, per 100,000 of the general population 15 years of age and over, 1930.[4]
2. Index of personnel in state hospitals, 1933.[5]
3. Index of expenditures of state hospitals, 1933.[6]
4. Combined index of care of state hospitals, 1933.[7]

In the comparisons based on each of the above four standard indices it is found that Georgia has a distinctly unfavorable status as compared with most other states. For example, in 1933 Georgia ranked 38th among the 48 states in the number of hospital beds available for mental patients. The Georgia index of capacity (258.0) is only 82 per cent of that of the median for the entire United States (312.8), and only 46 per cent as great as that of the highest ranking state (Massachusetts — 563.0). In view of the marked increase in the Georgia hospital population since 1933, and in view of the absence of a corresponding increase in hospital beds, it is quite likely that if 1939 comparisons were available, the

[4] Relative hospital capacity is based on the number of available hospital beds per 100,000 of the general population 15 years of age and over, 1930 census.

[5] The index of personnel is derived from a combination of three indices, as follows: (1) nurses and attendants per average daily resident population, 125 nurses and attendants per 1,000 patients equals 100; (2) physicians per average daily resident patient population, 6.667 physicians per 1,000 patients equals 100; (3) physicians per annual admissions, 25 physicians per 1,000 admissions equals 100.

[6] The index of expenditures is derived from a combination of two indices, as follows: (1) per capita cost of maintenance, $312 equals 100; (2) per capita value of hospital property in terms of average daily resident population, $1,500 per patient equals 100.

[7] The combined index of care is derived by an equal weighting of three factors involved in the index of personnel and the two factors involved in the index of expenditures.

status of Georgia would be even more unfavorable today than that indicated above for 1933. On the index of personnel (ratio of patients to physicians, nurses and attendants), Georgia ranked 34th among the 48 states in 1933. The Georgia index of personnel is 52.3 per cent of the minimum standards recommended by the American Psychiatric Association, is 86 per cent of that for the median of the United States as a whole, and only 42 per cent of that of the highest state (Delaware — 123.2). In 1933 Georgia ranked 45th among the 48 states on index of expenditures. The 1933 Georgia index of expenditures (45) is 45 per cent of the United States average expenditure in 1929, is 63 per cent of the United States median index of expenditures (72) in 1933, and only 28 per cent of the index of expenditures of the highest ranking state (Delaware — 159) in 1933. On the 1933 combined index of care Georgia ranked 42nd among the 48 states. The Georgia index of care is 76 per cent of that of the United States median and only 36 per cent of that of the highest ranking state (Delaware — 137.5).

THE PRESENT STUDY

The above summary of previous studies is meant to serve as a background for evaluating the findings to be reported in this section of the paper. It will be recognized by the reader, as it has been by the writers, that factors 8, 9, and 10 (percentages of patients discharged as "recovered", "improved", and "unimproved") have serious limitations as bases for determining the extent of racial and regional differences in therapeutic results among mental patients. It is noted, for example, that such percentages merely refer to the relative distribution into one category or another (i.e. "recovered", or "improved", or "unimproved") of such patients as may be discharged; they do not show the ratio of the various categories of discharged patients to the total number of resident patients susceptible of discharge. As a supplement to such raw percentage data, it has seemed advisable to attempt to utilize more exact and valid measures of therapeutic results in the racial and regional comparisons to be reported below.

Procedure

In order that directly comparable data might be available for analysis, the same seven clinical categories of disorders utilized in the previous

studies serve as bases for the three following series of inter-racial and inter-area comparisons:

A. Comparisons based on standard "recovery" rates (i.e. number of patients discharged as "recovered" within a given category per 100 resident patients of the same category).

B. Comparisons based on standard "improvement" rates (i.e. number of patients discharged as "improved" within a given category per 100 resident patients of the same category).

C. Comparisons based on standard "unimprovement" rates (i.e. number of patients discharged as "unimproved" within a given category per 100 resident patients of the same category).

As was the case in the previous studies, the present data on Georgia patients were obtained from the Annual Reports of the Georgia State Hospital for the Insane for each of the years 1923-32, inclusive. Corresponding data on United States patients were available only for the year 1923. Consequently, it should be noted that the various inter-area (U.S. versus Georgia) comparisons are subject to limitations due to the unavailability of directly comparable data for each of the same years. The reliability of the obtained inter-racial (Tables 1 and 2) and inter-area (Tables 3 and 4) differences in standard therapy rates are expressed in the conventional form (critical ratios and chances in 100 of a true difference).

It has not been possible to secure complete data relative to the reliability of the present sampling. It should be said, however, that the Georgia data represent approximately 98 per cent of all hospitalized mental patients in Georgia during the decade under study. The United States data are believed to be sufficiently reliable for control purposes, although exact information on this point is not available. It is recognized, of course, that the present data are subject to the inaccuracies due to subjective categorization, clerical ineptness, etc., commonly found in records of hospitalized patients.

SUMMARY OF FINDINGS

Supporting data for the summary generalizations offered below are to be found in a series of six accompanying tables. In the analyses to follow it has been considered advisable to report the obtained differences

in standard therapy rates in terms of so-called "favorable" or "unfavorable" ratings of one race (Table 5) or area (Table 6) as compared with the other race or area. Such "favorable" ratings would result from: (1) comparatively *high* standard "recovery" rates — presumably showing comparatively low initial susceptibility to serious mental disturbance, or preferential therapy, or low standards relative to "discharge", or some combination of these factors; (2) relatively *high* standard "improvement" rates — presumably indicating the presence of any one or any combination of the characteristics listed above, but to a lesser extent; (3) comparatively *low* standard "unimprovement" rates — presumably indicating a relatively marked constitutional resiliency to mental disorders, or preferential therapy, or high standards relative to "discharge", or some combination of these factors. "Unfavorable" ratings have exactly reverse connotations to those indicated above for "favorable" ratings. It is recognized, of course, that these terms fail to indicate the magnitude and reliability of such inter-racial and inter-area differences as may be found to exist, and that in some instances the presumably "favorable" rating of one race or area as compared with the other race or area may be more apparent than real. However, despite the limitations involved in the use of relative comparisons of this sort, it is believed that a judicious interpretation of such comparisons will prove significant.

RACIAL DIFFERENCES IN STANDARD THERAPY RATES

Georgia comparisons (Table 1). When all clinical groups are considered, the comparisons are favorable to whites in "recovery" rates (total and male) and in "improvement" rates (total, male and female), but favorable to Negroes in "unimprovement" rates (total, male and female). Inter-racial comparisons based on the six specific disorders show pronounced sex differences in standard "recovery" rates: white males have higher "recovery" rates than Negro males, whereas white females have lower "recovery" rates than Negro females. In these six disorder categories the comparisons based on standard "improvement" rates are generally favorable to whites, but "unimprovement" rates tend to be favorable to Negroes.

United States comparisons (Table 2). When all clinical groups are considered, there is a reliable difference favorable to whites on "im-

TABLE 1

Racial differences in certain standard therapy rates among whites and Negroes in Georgia (I) within each of six specific disorder categories and (II) within all clinical groups combined*

(The amount and reliability of "whites minus Negroes" differences** are indicated at the base of the table. Negative signs indicate that Negroes have a higher percentage in a given category than do whites.)

	SENILE			CEREBRAL ARTERIOSCLEROSIS			GENERAL PARALYSIS			CEREBRAL SYPHILIS			MANIC-DEPRESSIVE			DEMENTIA PRAECOX			ALL CLINICAL GROUPS		
	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female
Whites																					
Standard "recovery" rates	..	..	..	.6	.7	.4	.5	.4	.9	13.0	4.3	...	8.4	9.4	7.6	.4	.2	.6	5.4	6.9	4.1
Standard "improvement" rates	3.6	5.4	2.8	14.6	14.9	13.7	10.5	10.6	9.1	26.1	26.1	...	13.0	12.0	13.9	6.6	7.4	5.9	11.2	12.9	9.8
Standard "unimprovement" rates	2.9	4.9	2.0	7.1	6.9	7.9	3.3	3.5	1.8	21.7	13.0	...	2.3	1.6	2.9	3.2	3.0	3.4	3.9	4.4	3.6
Negroes																					
Standard "recovery" rates	..	..	..	1.5	1.9	.8	...	...	...	1.0	...	1.8	8.7	7.1	9.6	.6	.2	.8	3.3	2.2	4.3
Standard "improvement" rates	.8	1.2	.7	9.1	6.8	12.8	9.2	6.0	17.5	13.5	19.1	8.7	16.1	23.5	12.0	5.6	4.0	6.5	9.0	9.0	9.0
Standard "unimprovement" rates	1.1	3.6	.4	2.3	2.2	2.5	4.4	4.2	5.0	5.8	4.3	7.0	1.9	3.5	.9	2.1	3.5	1.3	2.4	3.6	1.4
"Whites minus Negroes" differences in standard rates																					
Diff. in "recovery" rates	..	..	..	—.9	—1.2	—.4	.5	.4	.9	12.0	4.3	—1.8	—.3	2.3	—2.0	—.2	...	—.2	2.1	4.7	—.2
Diff./Sigma diff.	..	..	..	1.8	1.5	.6	2.5	2.0	1.0	1.7	1.0	1.0	.6	3.3	3.3	2.0	...	1.0	10.5	15.7	1.0
Chances in 100 of true diff.	50	50	50	96	93	73	99	98	84	96	84	84	73	100	100	98	50	84	100	100	84
Diff. in "improvement" rates	2.8	4.2	2.1	5.5	8.1	.9	1.3	4.6	—8.4	12.6	7.0	—8.7	—3.1	—11.5	1.9	1.0	3.4	—.6	2.2	3.9	.8
Diff./Sigma diff.	3.1	2.1	2.4	3.4	4.3	.3	.8	2.7	2.0	1.3	.6	2.4	5.2	10.5	2.7	2.5	7.0	1.2	7.4	9.8	2.0
Chances in 100 of true diff.	100	98	99	100	100	62	79	100	98	90	73	99	100	100	100	99	100	88	100	100	98
Diff. in "unimprovement" rates	1.8	1.3	1.6	4.8	4.7	5.4	—1.1	—.7	—3.2	15.9	8.7	—7.0	.4	—1.9	2.0	1.1	—.5	2.1	1.5	.8	2.2
Diff./Sigma diff.	2.3	.5	2.0	4.4	4.0	2.6	1.0	.6	1.5	1.8	1.1	2.1	2.0	3.8	6.7	5.5	1.3	7.0	15.0	2.7	11.0
Chances in 100 of true diff.	99	69	98	100	100	100	84	73	93	96	86	98	98	100	100	100	90	100	100	100	100

* The three standard therapy rates employed are as follows: (1) Standard "recovery" rates indicate the number of patients discharged as "recovered" within a given category per 100 resident patients of the same category; (2) Standard "improvement" rates indicate the number of patients discharged as "improved" within a given category per 100 resident patients of the same category; (3) Standard "unimprovement" rates indicate the number of patients discharged as "unimproved" within a given category per 100 resident patients of the same category.

** All comparisons herein reported are based on data from the Georgia State Hospital reports for the years 1923-1932 inclusive.

TABLE 2

Racial differences in certain standard therapy rates among whites and Negroes in the United States (I) within each of six specific disorder categories and (II) within all clinical groups combined*

(The amount and reliability of "whites minus Negroes" differences** are indicated at the base of the table. Negative signs indicate that Negroes have a higher standard rate in a given category than do whites.)

	SENILE			CEREBRAL ARTERIOSCLEROSIS			GENERAL PARALYSIS			CEREBRAL SYPHILIS			MANIC-DEPRESSIVE			DEMENTIA PRAECOX			ALL CLINICAL GROUPS		
	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female
Whites																					
Standard "recovery" rates	.7	.9	.6	1.7	1.7	1.7	.4	.4	.6	3.2	3.4	2.6	14.1	14.6	13.7	1.1	1.2	1.0	4.5	4.5	4.4
Standard "improvement" rates	7.1	7.4	6.8	13.3	12.9	13.8	10.2	10.0	10.9	13.8	14.8	11.7	13.1	13.2	13.0	5.9	6.4	5.2	9.1	9.8	8.4
Standard "unimprovement" rates	5.4	6.0	4.9	6.0	6.6	5.2	9.3	9.7	7.7	8.6	9.0	7.5	3.5	3.8	3.3	3.1	3.7	2.4	6.1	7.5	4.5
Negroes																					
Standard "recovery" rates	.6	1.0	.4	1.6	2.1	.9	.5	.5	.4	2.4	2.7	2.1	12.1	13.8	10.9	1.5	1.2	1.7	4.6	4.6	4.7
Standard "improvement" rates	5.1	5.2	4.9	9.3	7.0	12.3	8.4	8.1	9.3	12.8	13.4	11.9	5.9	6.1	5.7	6.0	6.0	6.0	6.3	6.4	6.2
Standard "unimprovement" rates	2.6	3.7	1.7	4.0	2.1	6.6	4.1	4.4	3.3	.7	.8	.5	1.2	1.6	1.0	2.3	2.6	1.9	3.4	4.3	2.5
"Whites minus Negroes" differences in standard rates																					
Diff. in "recovery" rates	.1	—.1	.2	.1	—.4	.8	—.1	—.1	.2	.8	.7	.5	2.0	.8	2.8	—.4	...	—.7	—.1	—.1	—.3
Diff./Sigma diff.	.3	.2	.7	.1	.3	.8	.3	.3	.5	1.1	.6	.4	4.0	.9	4.0	2.0	...	3.5	.5	.5	1.5
Chances in 100 of true diff.	62	58	76	54	62	79	62	62	69	86	73	65	100	82	100	98	50	100	69	69	93
Diff. in "improvement" rates	2.0	2.2	1.9	4.0	5.9	1.5	1.8	1.9	1.6	1.0	1.4	—.2	7.2	7.1	7.3	—.1	.4	—.8	2.8	3.4	2.2
Diff./Sigma diff.	2.5	1.8	1.9	2.1	2.7	.5	1.8	1.6	.8	.6	.6	.1	18.0	11.9	14.6	.3	1.0	2.0	14.0	11.3	7.3
Chances in 100 of true diff.	99	96	97	98	100	69	96	94	79	73	73	54	100	100	100	62	84	98	100	100	100
Diff. in "unimprovement" rates	2.8	2.3	3.2	2.0	4.5	—1.4	5.2	5.3	4.4	7.9	8.2	7.0	2.3	2.2	2.3	.8	1.1	.5	2.7	3.2	2.0
Diff./Sigma diff.	4.7	2.3	5.3	1.5	3.5	.6	7.4	6.0	3.4	8.8	7.5	5.0	11.5	7.3	11.5	4.0	3.7	2.5	13.5	16.0	10.0
Chances in 100 of true diff.	100	99	100	93	100	73	100	100	100	100	100	100	100	100	100	100	100	99	100	100	100

* The three standard therapy rates employed are as follows: (1) Standard "recovery" rates indicate the number of patients discharged as "recovered" within a given category per 100 resident patients of the same category; (2) Standard "improvement" rates indicate the number of patients discharged as "improved" within a given category per 100 resident patients of the same category; (3) Standard "unimprovement" rates indicate the number of patients discharged as "unimproved" within a given category per 100 resident patients of the same category.

** All comparisons herein reported are based on data from the various State Hospital reports for the entire United States for the year 1923.

provement" rates, and a reliable difference favorable to Negroes on "unimprovement" rates. The difference on "recovery" rates is favorable to Negroes, but not reliably so. When the six separate clinical categories are considered, the comparisons on "improvement" rates are also generally favorable to whites; those on "unimprovement" rates favorable to Negroes. Again the differences on "recovery" rates are generally unreliable; but on two categories (manic-depressive — total and female; dementia praecox — female), a reliable difference favorable to whites appears.

REGIONAL DIFFERENCES IN STANDARD THERAPY RATES

White comparisons (Table 3). Only one (viz. "recovered" female discharges) out of nine comparisons based on all clinical groups is favorable to the United States: eight of the nine comparisons are favorable to Georgia and each has complete statistical reliability. When the six specific disorders are considered, the following findings are noted; "recovery" rates are generally favorable to the United States; "improvement" rates are slightly favorable to Georgia, except among females; "unimprovement" rates are likewise slightly favorable to Georgia.

Negro comparisons (Table 4). In the comparisons based on all clinical groups, "recovery" rates are uniformly and reliably favorable to the United States; however, both the "improvement" and "unimprovement" rates are uniformly and reliably favorable to Georgia. When the six specific disorders are considered, the "recovery" rates are uniformly (and in many instances, reliably) favorable to the United States. When merely the sum of the six disorders is considered, the comparisons based on standard "improvement" rates and standard "unimprovement" rates show no consistent differences between Georgia and the United States. However, when *each* of the six disorders is considered *separately,* marked and statistically reliable regional differences are occasionally found (e.g. among manic-depressive patients Georgia has a markedly and reliably higher standard "improvement" rate and a considerably higher "unimprovement" rate than does the United States).

CONCLUSIONS

Despite the conflicting trends and lack of complete reliability in certain of the data, a few general conclusions appear to be warranted.

proved" within a given category per 100 resident patients of the same category.
** All comparisons herein reported are based on data from the various State Hospital reports for the entire United States for the year 1923.

TABLE 3

Regional differences in certain standard therapy rates among whites in the United States and in Georgia (I) within each of six specific disorder categories and (II) within all clinical groups combined*

(The amount and reliability of "United States minus Georgia" differences** are indicated at the base of the table. Negative signs indicate that Georgia has a higher standard rate in a given category than does the United States.)

	SENILE			CEREBRAL ARTERIOSCLEROSIS			GENERAL PARALYSIS			CEREBRAL SYPHILIS			MANIC-DEPRESSIVE			DEMENTIA PRAECOX			ALL CLINICAL GROUPS		
	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female
United States																					
Standard "recovery" rates	.7	.9	.6	1.7	1.7	1.7	.4	.4	.6	3.2	3.4	2.6	14.1	14.6	13.7	1.1	1.2	1.0	4.5	4.5	4.4
Standard "improvement" rates	7.1	7.4	6.8	13.3	12.9	13.8	10.2	10.0	10.9	13.8	14.8	11.7	13.1	13.2	13.0	5.9	6.4	5.2	9.1	9.8	8.4
Standard "unimprovement" rates	5.4	6.0	4.9	6.0	6.6	5.2	9.3	9.7	7.7	8.6	9.0	7.5	3.5	3.8	3.3	3.1	3.7	2.4	6.1	7.5	4.5
Georgia																					
Standard "recovery" rates	..	..	..	.6	.7	.4	.5	.4	.9	13.0	4.3	...	8.4	9.4	7.6	.4	.2	.6	5.4	6.9	4.1
Standard "improvement" rates	3.6	5.4	2.8	14.6	14.9	13.7	10.5	10.6	9.1	26.1	26.1	...	13.0	12.0	13.9	6.6	7.4	5.9	11.2	12.9	9.8
Standard "unimprovement" rates	2.9	4.9	2.0	7.1	6.9	7.9	3.3	3.5	1.8	21.7	13.0	...	2.3	1.6	2.9	3.2	3.0	3.4	3.9	4.4	3.6
"U. S. minus Georgia" differences in standard rates																					
Diff. in "recovery" rates	.7	.9	.6	1.1	1.0	1.3	—.1	...	—.3	—9.8	—.9	2.6	5.7	5.2	6.1	.7	1.0	.4	—.9	—2.4	.3
Diff./Sigma diff.	7.0	9.0	6.0	3.7	2.5	2.6	.5	...	.3	1.4	.2	3.3	19.0	10.0	15.3	7.0	10.0	4.0	9.0	12.0	3.0
Chances in 100 of true diff.	100	100	100	100	99	99	69	50	62	92	58	100	100	100	100	100	100	100	100	100	100
Diff. in "improvement" rates	3.5	2.0	4.0	—1.3	—2.0	.1	—.3	—.6	1.8	—12.3	—11.3	11.7	.1	1.2	—.9	—.7	—1.0	—.7	—2.1	—3.1	—1.4
Diff./Sigma diff.	4.4	1.3	5.0	1.0	1.3	.1	.3	.5	.6	1.3	1.2	7.3	.3	2.4	1.8	3.5	2.5	2.3	10.5	10.3	7.0
Chances in 100 of true diff.	100	90	100	84	90	54	62	69	73	90	88	100	62	99	96	100	99	99	100	100	100
Diff. in "unimprovement" rates	2.5	1.1	2.9	—1.1	—.3	—2.7	6.0	6.2	5.9	—13.1	—4.0	7.5	1.2	2.2	.4	—.1	.7	—1.0	2.2	3.1	.9
Diff./Sigma diff.	3.5	.7	4.1	1.2	.3	1.4	8.6	7.8	4.2	1.5	.6	5.8	6.0	11.0	2.0	.5	3.5	5.0	22.0	15.5	9.0
Chances in 100 of true diff.	100	76	100	88	62	92	100	100	100	93	73	100	100	100	98	69	100	100	100	100	100

* The three standard therapy rates employed are as follows: (1) Standard "recovery" rates indicate the number of patients discharged as "recovered" within a given category per 100 resident patients of the same category; (2) Standard "improvement" rates indicate the number of patients discharged as "improved" within a given category per 100 resident patients of the same category; (3) Standard "unimprovement" rates indicate the number of patients discharged as "unimproved" within a given category per 100 resident patients of the same category.

** In all the comparisons herein reported the Georgia data are based on the years 1923-1932 inclusive and the United States data are based on the year 1923.

TABLE 4

proved" within a given category per 100 resident patients of the same category.

** In all the comparisons herein reported the Georgia data are based on the years 1923-1932 inclusive and the United States data are based on the year 1923.

TABLE 4

Regional differences in certain standard therapy rates among Negroes in the United States and in Georgia (I) within each of six specific disorder categories and (II) within all clinical groups combined*

(The amount and reliability of "United States minus Georgia" differences** are indicated at the base of the table. Negative signs indicate that Georgia has a higher standard rate in a given category than does the United States.)

	SENILE			CEREBRAL ARTERIOSCLEROSIS			GENERAL PARALYSIS			CEREBRAL SYPHILIS			MANIC-DEPRESSIVE			DEMENTIA PRAECOX			ALL CLINICAL GROUPS		
	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female
United States																					
Standard "recovery" rates	.6	1.0	.4	1.6	2.1	.9	.5	.5	.4	2.4	2.7	2.1	12.1	13.8	10.9	1.5	1.2	1.7	4.6	4.6	4.7
Standard "improvement" rates	5.1	5.2	4.9	9.3	7.0	12.3	8.4	8.1	9.3	12.8	13.4	11.9	5.9	6.1	5.7	6.0	6.0	6.0	6.3	6.4	6.2
Standard "unimprovement" rates	2.6	3.7	1.7	4.0	2.1	6.6	4.1	4.4	3.3	.7	.8	.5	1.2	1.6	1.0	2.3	2.6	1.9	3.4	4.3	2.5
Georgia																					
Standard "recovery" rates	..	..	..	1.5	1.9	.8	...	...	...	1.0	...	1.8	8.7	7.1	9.6	.6	.2	.8	3.3	2.2	4.3
Standard "improvement" rates	.8	1.2	.7	9.1	6.8	12.8	9.2	6.0	17.5	13.5	19.1	8.7	16.1	23.5	12.0	5.6	4.0	6.5	9.0	9.0	9.0
Standard "unimprovement" rates	1.1	3.6	.4	2.3	2.2	2.5	4.4	4.2	5.0	5.8	4.3	7.0	1.9	3.5	.9	2.1	3.5	1.3	2.4	3.6	1.4
"U. S. minus Georgia" differences in standard rates																					
Diff. in "recovery" rates	.6	1.0	.4	.1	.2	.1	.5	.5	.4	1.4	2.7	.3	3.4	6.7	1.3	.9	1.0	.9	1.3	2.4	.4
Diff./Sigma diff.	3.0	2.0	1.3	.1	.1	.1	2.5	1.7	1.0	1.2	2.7	.2	4.9	6.7	1.6	4.5	5.0	3.0	6.5	8.0	1.3
Chances in 100 of true diff.	100	98	90	54	54	54	99	96	84	88	100	58	100	100	94	100	100	100	100	100	90
Diff. in "improvement" rates	4.3	4.0	4.2	.2	.2	—.5	—.8	2.1	—8.2	—.7	—5.7	3.2	—10.2	—17.4	—6.3	.4	2.0	—.5	—2.7	—2.6	—2.8
Diff./Sigma diff.	5.4	2.5	3.8	.1	.1	.1	.5	1.2	2.3	.2	.9	.7	14.6	14.5	7.9	1.0	4.0	1.0	9.0	6.5	7.0
Chances in 100 of true diff.	100	99	100	54	54	54	69	88	99	58	82	76	100	100	100	84	100	84	100	100	100
Diff. in "unimprovement" rates	1.5	.1	1.3	1.7	—.1	4.1	—.3	.2	—1.7	—5.1	—3.5	—6.5	—.7	—1.9	.1	.2	—.9	.6	1.0	.7	1.1
Diff./Sigma diff.	1.9	.1	1.9	1.2	.1	1.6	.3	.2	.9	2.2	1.2	1.9	2.7	3.8	.3	1.0	2.3	2.0	5.0	2.3	5.5
Chances in 100 of true diff.	97	54	97	88	54	94	62	58	82	99	88	97	100	100	62	84	99	98	100	99	100

* The three standard therapy rates employed are as follows: (1) Standard "recovery" rates indicate the number of patients discharged as "recovered" within a given category per 100 resident patients of the same category; (2) Standard "improvement" rates indicate the number of patients discharged as "improved" within a given category per 100 resident patients of the same category; (3) Standard "unimprovement" rates indicate the number of patients discharged as "unimproved" within a given category per 100 resident patients of the same category.

** In all the comparisons herein reported the Georgia data are based on the years 1923-1932 inclusive and the United States data are based on the year 1923.

TABLE 5

Racial differences in certain standard therapy rates among whites and Negroes in Georgia and in the United States (I) within six specific disorder categories and (II) within all clinical groups combined

CLASSIFICATION OF DISCHARGED PATIENTS	WHITES VERSUS NEGROES—GEORGIA PATIENTS						WHITES VERSUS NEGROES—U. S. PATIENTS					
	*Sum of six disorders (I)**			*All clinical groups (II)***			*Sum of six disorders (I)**			*All clinical groups (II)***		
	Ratings favorable to whites	Ratings favorable to Negroes	Ratings favorable to neither	Ratings favorable to whites	Ratings favorable to Negroes	Ratings favorable to neither	Ratings favorable to whites	Ratings favorable to Negroes	Ratings favorable to neither	Ratings favorable to whites	Ratings favorable to Negroes	Ratings favorable to neither
1a. "Recovered" discharges—Total †	2	3	1	1	..	..	4	2	..	..	1	..
1b. "Recovered" discharges—Male	3	1	2	1	..	..	2	3	1	..	1	..
1c. "Recovered" discharges—Female	1	4	1	..	1	..	5	1	..	..	1	..
2a. "Improved" discharges—Total †	5	1	..	1	..	..	5	1	..	1	..	..
2b. "Improved" discharges—Male	5	1	..	1	..	..	6	..	..	1	..	..
2c. "Improved" discharges—Female	3	3	..	1	..	..	4	2	..	1	..	..
3a. "Unimproved" discharges—Total †	1	5	..	..	1	..	..	6	..	..	1	..
3b. "Unimproved" discharges—Male	3	3	..	..	1	..	..	6	..	..	1	..
3c. "Unimproved" discharges—Female	2	4	..	..	1	..	1	5	..	..	1	..
Total discharges (1a, 2a, 3a,)—Total †	8	9	1	2	1	..	9	9	..	1	2	..
Total discharges (1b, 2b, 3b)—Male	11	5	2	2	1	..	8	9	1	1	2	..
Total discharges (1c, 2c, 3c)—Female	6	11	1	1	2	..	10	8	..	1	2	..

* The six specific disorder categories involved are: (1) Senile (2) Cerebral arteriosclerosis (3) General paralysis (4) Cerebral syphilis (5) Manic-depressive (6) Dementia praecox.

** The term "All clinical groups" refers to all mental disorders of every type.

† The designation "Total," as herein used, refers to comparisons in which the sex of patients is disregarded (i.e. male and female patients are combined to form a single group of the entire race concerned).

TABLE 6

Regional differences in certain standard therapy rates among whites and Negroes in Georgia and in the United States (I) within six specific disorder categories and (II) within all clinical groups combined

CLASSIFICATION OF DISCHARGED PATIENTS	UNITED STATES VERSUS GEORGIA—WHITE PATIENTS						UNITED STATES VERSUS GEORGIA—NEGRO PATIENTS					
	*Sum of six disorders (I)**			*All clinical groups (II)***			*Sum of six disorders (I)**			*All clinical groups (II)***		
	Ratings favorable to U. S.	Ratings favorable to Georgia	Ratings favorable to neither	Ratings favorable to U. S.	Ratings favorable to Georgia	Ratings favorable to neither	Ratings favorable to U. S.	Ratings favorable to Georgia	Ratings favorable to neither	Ratings favorable to U. S.	Ratings favorable to Georgia	Ratings favorable to neither
1a. "Recovered" discharges—Total †	4	2	..	..	1	..	6	..	..	1	..	..
1b. "Recovered" discharges—Male	4	1	1	..	1	..	6	..	..	1	..	..
1c. "Recovered" discharges—Female	5	1	..	1	..	..	6	..	..	1	..	..
2a. "Improved" discharges—Total †	2	4	..	..	1	..	3	3	..	..	1	..
2b. "Improved" discharges—Male	2	4	..	..	1	..	4	2	..	..	1	..
2c. "Improved" discharges—Female	4	2	..	..	1	..	2	4	..	..	1	..
3a. "Unimproved" discharges—Total †	3	3	..	..	1	..	3	3	..	..	1	..
3b. "Unimproved" discharges—Male	2	4	..	..	1	..	4	2	..	..	1	..
3c. "Unimproved" discharges—Female	2	4	..	..	1	..	2	4	..	..	1	..
Total discharges (1a, 2a, 3a,)—Total †	9	9	..	..	3	..	12	6	..	1	2	..
Total discharges (1b, 2b, 3b)—Male	8	9	1	..	3	..	14	4	..	1	2	..
Total discharges (1c, 2c, 3c)—Female	11	7	..	1	2	..	10	8	..	1	2	..

* The six specific disorder categories involved are: (1) Senile (2) Cerebral arteriosclerosis (3) General paralysis (4) Cerebral syphilis (5) Manic-depressive (6) Dementia praecox.

** The term "All clinical groups" refers to all mental disorders of every type.

† The designation "Total," as herein used, refers to comparisons in which the sex of patients is disregarded (i.e. male and female patients are combined to form a single group of the entire race concerned).

Racial differences in standard therapy rates are found to exist both in Georgia and in the United States. In the six disorder groups, these differences are generally larger and more reliable in the Georgia comparisons than in the United States comparisons. The amount and direction of the obtained racial differences vary from one standard rate to another and from one clinical category to another. Pronounced sex differences are also noted in the Georgia racial comparisons; the differences favorable to Negroes being found mainly among female comparisons and vice versa. In both Georgia and the United States the differences which are most favorable to the Negroes are those based on "unimprovement" rates. *Regional* differences in standard therapy rates are found among both whites and Negroes. In the six specific disorders, Georgia whites compare more favorably with the United States whites than do Georgia Negroes with United States Negroes. It should be noted, however, that the regional differences likewise vary from one standard therapy rate to another and from one disorder group to another.

While the writers do not presume to attempt to explain the causes of the inter-racial and inter-area differences here reported, it is customary in explaining data of this type to advance one or both of two general causal factors: (1) constitutional; (2) sociological. It appears to the writers that the present and related data warrant more of a sociological than a constitutional explanatory emphasis.

THE FUNCTION OF THE ARMS IN WALKING

BY HERBERT ELFTMAN

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WITH the assumption of the erect position of the body in walking, the arms of man were liberated from their traditional function of aiding in the support and propulsion of the body. In spite of this, they have continued to take part in the movements of the body accompanying locomotion, although with a more varied pattern of activity. It consequently seems worth while to inquire whether the swinging of the arms in walking is merely that of pendulums reacting to the movements of their points of attachment or the movements are of muscular origin and play some part in the integrated activity of locomotion.

This problem can be investigated if the instantaneous positions of the various parts of the body are accurately known. Such information is not particularly difficult to procure for plane motion, since it may be obtained by measurement of moving pictures. The movements of the arms, however, take place in three dimensions, increasing greatly the difficulty of obtaining the necessary data. Fortunately Braune and Fischer (1), with the aid of four cameras and a computer, obtained the necessary determinations of the positions in space of the joints and of the centers of gravity of the various parts of the body. From the fundamental data of their second experiment we have computed the velocities and accelerations, both linear and angular, for all parts of the body during the interval in which the right foot was on the ground.

ANGULAR MOMENTUM OF THE ARMS

The angular momentum of a part of the body about the center of gravity of the whole body is equal to the vector sum of the angular momentum of the part about its own center of gravity and the angular momentum of the part, considered as concentrated at its mass center, about the center of gravity of the whole body. This may be written $\mathbf{h} = \mathbf{s} \times m\dot{\mathbf{s}} + \Phi \cdot \omega$, in which $\mathbf{h}$ is a vector representing the angular

momentum of the part about the center of gravity of the whole body; $\mathbf{s}$ is a line vector from the center of gravity of the whole body to the center of gravity of the part; m is the mass of the part in gravitational units; $\dot{\mathbf{s}}$ is the time rate of change of $\mathbf{s}$; Φ is the inertia dyadic of the part, determined for the subject of this experiment from the data of Fischer (5); and ω is the angular velocity of the part. By this means the angular momentum was calculated for the parts into which Fischer divided the body, except that the head and trunk were considered together. Extensive tables of the fundamental data for these computations may be found on pp. 260-261 of Braune and Fischer (1) and pp. 49-51 of Fischer (4).

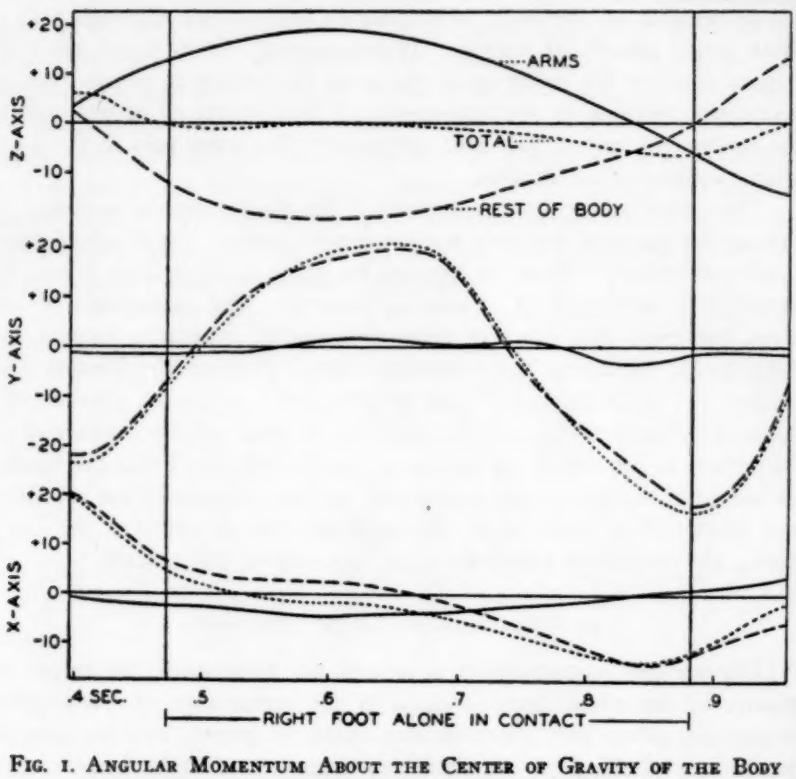

FIG. 1. ANGULAR MOMENTUM ABOUT THE CENTER OF GRAVITY OF THE BODY FOR THE ARMS, THE REST OF THE BODY, AND THE BODY AS A WHOLE, IN THREE COMPONENTS
Angular momentum in kg.cm.sec.

The angular momentum, in kg.cm.sec., is plotted in Fig. 1 for the arms, for the rest of the body, and for the body as a whole, in three components. The three axes chosen by Fischer have been retained, the Z axis being vertical; the X axis horizontal and directed forward in the direction of movement; and the Y axis lateral, with positive values to the right. This orientation of positive values along the Y axis is contrary to common usage but is retained in order that comparison with Fischer's data may not lead to confusion.

A consideration of the curves for angular momentum about the vertical, or Z axis, provides a solution for one aspect of the problem. With the exception of a short interval immediately preceding the planting of a foot on the ground, the angular momentum of the arms is opposite in sign to the angular momentum of the rest of the body. It is therefore possible for the legs to go through the movements necessary for walking, without imparting marked rotation to the body as a whole. When the two curves are added together, giving the total angular momentum of the body about this axis, there is evident a rotation of the body of such a nature as to help bring the advancing foot into position for contact with the ground. As the foot is planted, the rotation of the combined legs and trunk changes direction. This would bring about a rapid change in the angular momentum of the body as a whole if it were not countered by the rotation of the arms. The effect of rotation of the arms about the vertical axis is, then, to decrease markedly the rotation of the body as a whole and to make more gradual the changes in rotation which occur.

A rough test may be made of the effect upon the rotation of the body due to the angular momentum of the arms, by swinging the arms in the normal rhythm but varying the distance at which they are held out from the body, or by varying the amplitude of the swing. If this is done while walking, it is possible to balance the angular momentum which the body receives from other sources or to produce rotation toward or away from the advancing foot.

About the lateral, or Y axis, the angular momentum of the arm is small when compared with that of the rest of the body. This is to be expected, since the center of gravity of the fore-arm is located at approximately the same vertical elevation as the center of gravity of the body, in contrast to the position of the leg. It is possible to vary this component by increasing the flexion of the elbow, thus raising the fore-arm, by increasing the amplitude of the swing, or by raising the entire

arm by increasing its lateral inclination to the body. These variations will also affect the other components.

The angular momentum of the arms about the X axis, or the direction of progression, is opposite in sign to that of the rest of the body except for a time during the latter half of the period during which only one foot is in contact. As the right foot reaches the ground, the arms decrease the rotation of the body as it tilts toward the right and then increase its rotation in the opposite direction. The angular momentum about this axis also may be increased by elevating the arms.

It thus becomes apparent that the swinging of the arms serves to regulate the rotation of the body as a whole, serving especially to decrease rotation about the vertical axis while only one foot is on the ground and to modify the rotation while both feet are in contact. The rotation of the body about the direction of progression is modified by the arms so that the change in direction of rotation is accomplished more smoothly. The magnitude of these effects depends on the amplitude of the swing, since this affects the velocity, and on the positions through which the arms swing, since they affect the distance of the parts from the center of gravity of the body.

EFFECT OF MUSCLES ON THE ARMS

The fact that the arms swing and consequently have the effects on the rotation of the body as a whole which have been noted does not dispose of the possibility that the arms are acting as compound pendulums, swinging under the influence of gravity and of the forces present at their points of attachment. Under these conditions the muscles would not be exerting forces or torques upon the arm. It is consequently possible to investigate this question, since the torques exerted by the muscles can be calculated by the method described by Elftman (2). The method involves a solution of the equations for equilibrium, all the members of which are known, with the exception of the muscle torque, which can consequently be found.

When this is done for the arms, it is found that the muscles are actually exerting a considerable torque. In Fig. 2 are plotted the values for the total torque exerted by muscles connecting the trunk and the arm, expressed in three components. We may consequently conclude that the swinging of the arms is not an example of pendulum action, but is brought about in large part by the action of muscles. Therefore

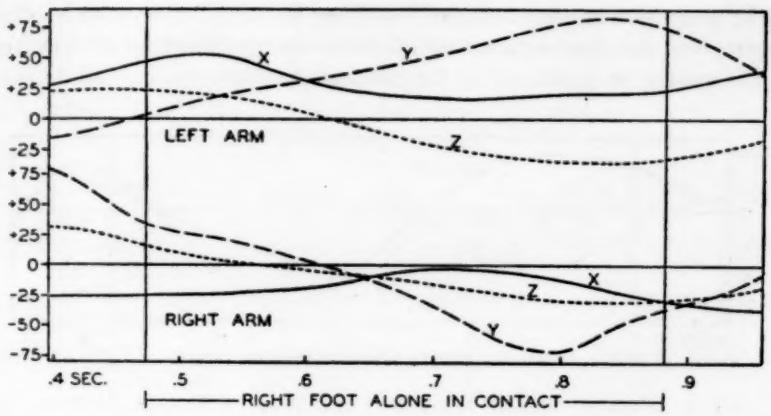

FIG. 2. RESULTANT MUSCLE TORQUE ON EACH ARM, IN THREE COMPONENTS
Torque in kg.cm.

it is not a merely incidental aspect of forward movement but an integral part of it, requiring nervous coordination to attune it to the other movements taking place.

WORK DONE BY THE ARM MUSCLES

It is possible to carry the study of the arm muscles one step further and to obtain a minimum value for the energy exchanges in which they are involved. Since the activity, or rate at which a torque does work, is the product of the torque and the angular velocity of the part upon which it acts, it is possible to compute the rate at which the muscle torques on the fore-arm, upper arm and trunk do work. When these values are computed for each part in three components and the figures for rate of work thus derived are added together, we obtain the rate at which the most efficient combination of muscles would be doing work. This efficiency is not reached in the body, but it serves as a minimum figure for the rate of energy exchange of the actual system. A detailed consideration of this subject will be found in Elftman (3).

The minimum rate at which the muscle tissue of each arm must be doing work or receiving energy is plotted in Fig. 3 in kg.cm./sec. When the sign is positive, it indicates that the muscles are doing work; when it is negative, work is being done on the muscle, so that it is receiving energy. In other words, when a muscle under tension shortens, it does

work, while if it is stretched, work is done on it. The area under each curve gives the total amount of physical energy liberated or received by the muscle, as measured by the external forces.

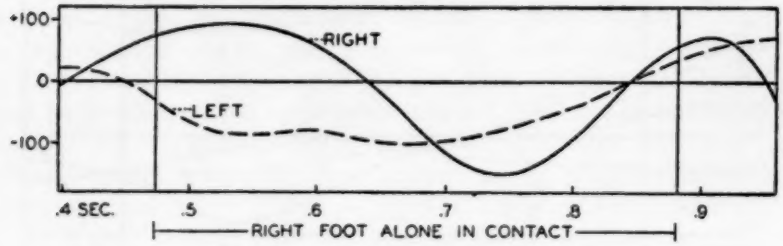

FIG. 3. RATE AT WHICH WORK IS BEING DONE OR ENERGY RECEIVED BY THE MUSCLES OF EACH ARM
In kg.cm./sec.

The activity curve for the muscles of the right arm differs from that for the left arm in Fig. 3. This is to be expected since one arm is moving forward with the rest of the body while the other arm is swinging backward. If the graph were continued so as to include the time during which the left foot alone is on the ground, the curves for the two arms should be similar, one being displaced with respect to the other by the time occupied by one-half of a double step. The curve for each arm would then complete two dissimilar cycles of positive and negative variation for each double step of the body.

SUMMARY

An analysis of the dynamics of the arm movements during walking shows that they decrease the rotation of the body as a whole about the vertical axis during the interval in which only one foot is on the ground and allow a more gradual change in the rotation of the body than would be possible without them. The arms also modify the rotation of the body about the direction of progression. The effect of the movements of the arms depends on the amplitude of their swing and on the positions through which the arms swing.

The arms do not behave as pendulums in typical walking but are subject to muscle action. This involves the alternate doing of work and reception of energy by the muscles of each arm in two cycles for

each double step. The swinging of the arms is consequently not a purely incidental accompaniment of forward movement but is an integral part of the dynamics of progression.

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THE HUMAN FINGER TIP: SURFACE AREA AND VOLUME CORRELATIONS*

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METHOD OF DETERMINING SURFACE AREA

THE human finger tip, which has been defined (Sodeman, '37; Turner, Burch and Sodeman, '37) as that portion of the terminal phalanx distal to a plane passing through the center of the major interphalangeal creases, has been found particularly suitable for certain studies in vascular physiology now being carried on in this laboratory. These studies indicated a need for a precise method for determining the surface area of the finger tip. The method here reported entails the making of a positive cast of the finger tip in dental stone† and the winding of the cast with fine wire, surface area being then calculated from the length and diameter of the wire.

With the finger held at heart level, a negative mold of the tip is made in dental stone. The mold may be used in the determination of total volume according to the method of Sodeman. A hole one-sixteenth inch in diameter and five-sixteenths inch in depth is drilled as nearly as possible into the central point of the distal extremity of the mold. The inside of the mold is lightly greased with vaseline, care being taken to wipe away any excess. A brass rod about three inches in length and one-fourth inch in diameter, which bears a threaded tip one-sixteenth inch in diameter and one-fourth inch long, is inserted into the drill hole. Liquid dental stone is poured into the mold, a small portion at a time,

* Aided by a grant from the Committee on Scientific Research of the American Medical Association.

† The proprietary product "Investone" was used.

and after each addition the mold is lightly tapped to bring air bubbles to the surface. When the mold is completely filled it is put aside for thirty minutes to allow the stone to set. The mold is then split with saw and chisel for removal of the positive cast, which, if properly made, is a perfect replica of the finger tip, showing clearly the dermatoglyphs. The cast is pierced by the brass rod, with the threaded tip protruding through the distal extremity and the unthreaded end from the proximal portion of the cast.

The cast is now placed in an apparatus designed to facilitate winding the wire. Detailed description of the apparatus is unnecessary, as many types, all equally efficient, could be constructed. The device used in this work consists essentially of a crank, fitted with a spring ratchet to prevent reverse motion. The crankshaft, which is hollow to receive the unthreaded portion of the brass rod protruding from the proximal portion of the cast, bears a setscrew whereby the rod may be tightly fixed. Wire is fed from a spool to the apparatus between two small fiber blocks attached to a slide which moves easily from side to side. Tension on the wire may be regulated by tightening or loosening the blocks by means of screws. The winding is begun by taking one turn of wire around the threaded portion of the rod and fixing this turn flush against the cast by screwing a small nut tightly against the wire. The winding, based on this first fixed turn, is carried back until the wire touches, or lies on, the center of the major creases of the terminal interphalangeal joint. When the winding is completed it is inspected with a hand lens. If gaps are noted between the turns the winding is repeated. Often the winding cannot be finished exactly, as the wire will reach one major crease before it reaches the other, or will cross a crease at an angle. A method for correcting for the error introduced by an inexact finish will be given below. Fine wire, usually Brown and Sharpe No. 30 gauge, obtainable under the name of "flower wire", is very satisfactory for winding the casts. It is very pliable, has a diameter of 0.033 cm., and does not change diameter under the tensions employed. After the winding is finished the wire is removed, its length determined to the nearest millimeter, and the length multiplied by the diameter. To the value obtained is added the area of the cross-section of the threaded portion of the rod protruding from the finger tip. The total is the surface area of the finger tip.

In order to test the accuracy of the method, ten models of the shapes of frustums of cones and of frustums of cones surmounted by hemi-

spheres were constructed. The surface areas of the models were determined by winding them according to the procedure described above. The values obtained, compared with the calculated surface areas, revealed a mean error of 0.1 per cent, a miximum error of 0.4 per cent, and a minimum error of 0.02 per cent. Castings were then made from the models by the technic described above, and the areas determined by winding were found to be identical with the areas found by winding the original models. Therefore, the method was considered accurate for the determination of the areas of geometrical models, and the casting technic was shown to introduce no gain or loss of surface area.

Since the finger tip is not a regular geometrical figure, the conclusion reached above was tested further. The main difference between regularly shaped geometrical models and casts of actual finger tips results from the depressed position of the nail below the ungual folds. As the wire crosses the nail it does not lie exactly on the nail, but bridges from the highest point of the ungual fold to the summit of the nail. In order to evaluate the magnitude of the error due to bridging of the wire, twelve models were constructed in forms simulating the finger tip, but deliberately designed to accentuate this source of error. Each was the frustum of a cone, bisected lengthwise to about the middle and transected for the removal of a block replaced by a corresponding portion of a smaller frustum. Four additional models were constructed in similar form but these were surmounted by hemispheres. The smallest model had an area of four square centimeters, the largest an area of 25.2 square centimeters. Comparison of the areas found by winding these models with the calculated surface areas gave a mean error of 1.30 ± 0.075 per cent, a maximum error of 4.3 per cent and a minimum error of 0.1 per cent. The calculated surface area exceeded the area determined by winding in each case. Those models surmounted by hemispheres most closely resembled the finger tip and gave the largest errors. For four such models the largest error observed was 4.3 per cent, the smallest 1.8 per cent, and the average 2.2 per cent. Castings were made from all the models and the area of castings determined as described above. Comparison of the areas of the castings found by winding with the areas found on the original models showed no significant gain or loss of surface area. Since the models were designed to accentuate the error due to the depressed position of the nail, the mean error produced by this factor in actual finger tips is likely less than 1.3 per cent.

Unless the brass rod pierces the central point of the distal extremity of the finger tip, and unless the plane passing through the major interphalangeal creases is perpendicular to the long axis of the finger, it is impossible to finish the winding exactly. The wire will not reach both creases at the same time, or will pass the plane of the major creases obliquely. In order to overcome this difficulty the following rules were arbitrarily laid down: If the wire passed the center of either major crease by as much as 1.65 mm. (five turns of the wire used) and was not yet within 1.65 mm. of the opposite crease, the determination was discarded; if the wire reached the center of a major crease and was within 1.65 mm. of the opposite crease, the determination was accepted. In order to evaluate the accuracy of these rules, twelve casts were made from one finger with the rods so placed that the wire reached the center of both major creases at the same time. Analysis of the results obtained by winding the casts gave a mean surface area of 11.29 square centimeters, a standard deviation of ±0.222, a standard error of the mean (Mainland '37) of ±0.074, and a standard error of the standard deviation of 0.016. A similar series of casts was then made except that the rods were purposely cast off center so that the windings had to be finished by the rules stated above. Analysis of the results gave a mean area of 11.34 square centimeters, a standard deviation of ±0.286, a standard error of the mean of ±0.095, and a standard error of the standard deviation of ±0.067. The results are not significantly different from those of the first series. Similar experiments on two other fingers gave comparable results indicating that no serious error was introduced by finishing the windings by the rules laid down above.

SURFACE AREA

Determinations were carried out on the right index fingers of 30 normal males of ages varying between 13 and 51 years. The casts were made from molds used for the determination of total volume in prior studies (Turner, Burch and Sodeman, '37; Sodeman, Burch and Turner, '37; Sodeman and Burch, '38). The largest area found was 14.02 square centimeters, the smallest 7.48 square centimeters, and the mean area 11.85 square centimeters, the standard deviation ±1.75, the standard error of the mean ±0.32, and the standard error of the standard deviation ±0.23. Excluding the younger subjects for a determination of strictly adult values, there remain 19 aged 21 years or more. These 19 individuals yield a mean surface area of 12.70 square centimeters, a

standard deviation of ±0.725 square centimeters, a standard error of the mean of ±0.183, and a standard error of the standard deviation of ±0.118.

Another set of determinations was carried out on the right index fingers of 31 males who were suffering with various types of vascular disease, using molds from the investigations cited above. Ages of the individuals studied varied between 21 and 75 years. Six were diagnosed as having severe generalized arteriosclerosis; 18 had systolic and diastolic hypertension; five had clubbed fingers, both the congenital and acquired varieties being represented; one had a dead finger due to Raynaud's phenomenon, and one had aortic regurgitation. Analysis of the results gave a mean area of 13.33 square centimeters, a standard deviation of ±0.35, and a standard error of the standard deviation of ±0.25. The largest area found was 16.95 square centimeters, the smallest 8.92. The results are not statistically different from those obtained on normal fingers. Both series were, therefore, combined and reanalyzed, giving a mean surface area of 12.61 square centimeters, a standard deviation of ±1.84, a standard error of the mean of ±0.24, and a standard error of the standard deviation of ±0.17.

VOLUME CORRELATIONS

Correlation of surface area with total volume

Correlation of the surface areas of the finger tips of the 61 individuals with the total volumes taken from the data of Turner, Burch and Sodeman gave a coefficient of correlation (Mainland) of +0.977±0.129. The equation expressing the regression of surface area on volume may be written:

$$S = 3.77 + 1.71V$$

where S is the surface area in square centimeters and V the total volume of the finger tip in cubic centimeters. Comparison of areas of the 61 finger tips calculated from the total volume with the areas found by measurement gave a mean difference of 1.6±0.05 per cent. The maximum difference observed was 3.8 per cent, the minimum 0.3 per cent.

Correlation of bloodless soft tissue volume with total volume of the finger tip

The values for bloodless soft tissue volume of the 61 finger tips were calculated (Turner, Burch and Sodeman) by subtracting from the total

volume the sum of the bone volume plus the loss of finger tip volume, determined plethysmographically, resulting from its drainage at 45 cm. above heart level followed by complete vascular occlusion. Correlation of these values with the total volumes of the finger tips gave a coefficient of correlation of $+0.976 \pm 0.129$. The equation expressing the regression of bloodless soft tissue volume on total volume may be written:

$$B = 0.165 + 0.811V$$

where B is the bloodless soft tissue volume in cubic centimeters, and V is the total volume in cubic centimeters. Comparison of the bloodless soft tissue volumes calculated from the total volume with the bloodless soft tissue volumes determined by measurement gave a mean difference of 2.50 ± 0.256 per cent. The maximum difference observed was 8.65 per cent, the minimum 0.15 per cent.

SUMMARY

A method for determining the surface area of the human finger tip, which entails the making of a cast of the tip in dental stone and the winding of the cast with fine wire, is reported. Determinations on the right index fingers of 61 males of ages from 13 to 75 years gave a mean area of 12.61 square centimeters. The smallest area found was 7.48 square centimeters, the largest 16.95 square centimeters.

Surface area and total volume were found to be highly correlated. The surface area may be calculated from the total volume by use of the regression equation:

$$S = 3.77 + 171V$$

Total volume and bloodless soft tissue volume were found to be highly correlated. The bloodless soft tissue volume may be calculated from the total volume by use of the regression equation:

$$B = 0.165 + 0.811V$$

I wish to thank Dr. Harold Cummins for his help in the preparation of this paper.

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NOTES

A NOMOGRAM FOR COMPUTATION OF PROBABLE ERRORS OF DIFFERENCES

THE nomogram which accompanies this note is a device which permits probable errors of differences to be solved at sight in all cases where the usual formula

$$p.e._{M-M'} = \sqrt{p.e._M^2 + p.e._{M'}^2}$$

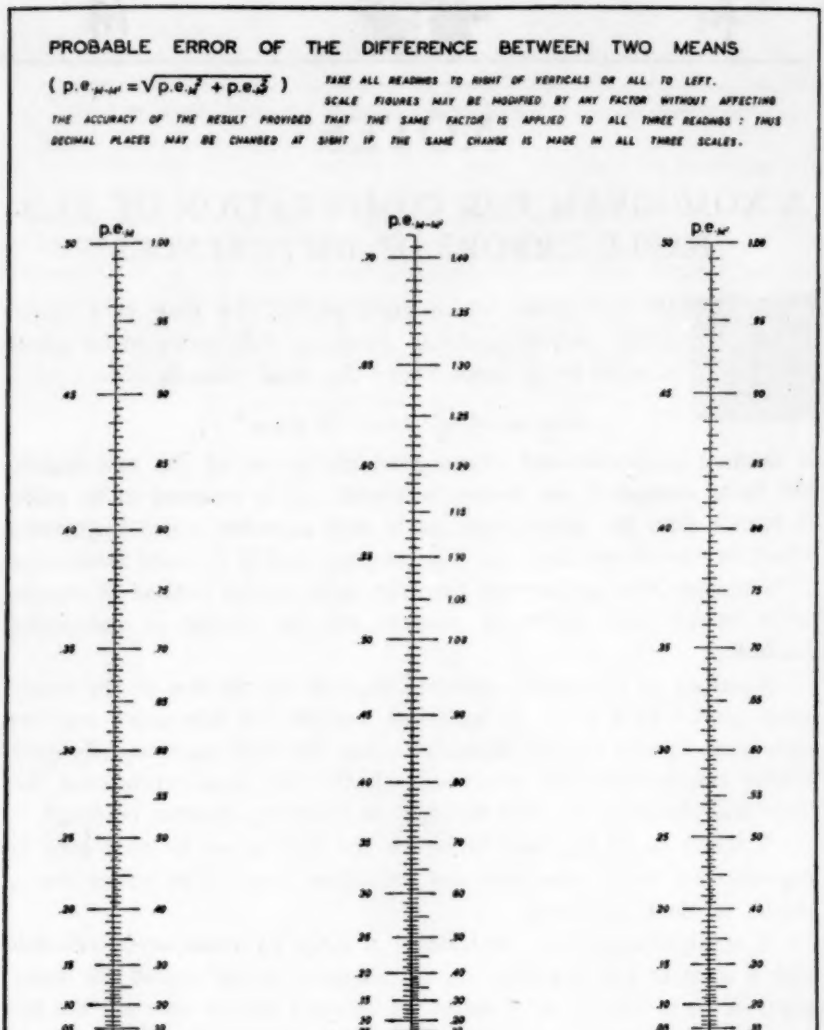
is deemed applicable and where probable errors of the two quantities being compared are already available. It is believed to be easier to handle than the scaled right angle with movable scaled hypotenuse which is sometimes used for this purpose, and it is more economical of laboratory time and energy than the more precise method of computation which uses tables of squares and an adding or calculating machine.

Accuracy of the results obtained depends on the size of the nomogram used. In a 9 × 12 inch size suitable for laboratory use two significant figures can be depended upon: in most cases equally good results can probably be obtained with the size here reproduced, but there will obviously be more difficulty in obtaining accurate readings.

A word as to the way in which the nomogram is used may be desirable for those who have not had other occasion to utilize nomograms in their problems.

A straight-edge (or, preferably, a strip of transparent celluloid with a straight line engraved on one surface) is laid across the nomogram in such fashion as to cause the straight line to intersect the left vertical at the scale level representing the known probable error of one of the two quantities being compared, and intersecting the right vertical at the level representing the other. Probable error of the difference is then read from the point of intersection of the straight line with the median vertical.

In order to increase the scope of the nomogram, each vertical has been provided with two scales. In each case, the right-hand scale


PROBABLE ERROR OF THE DIFFERENCE BETWEEN TWO MEANS
$(p.e_{M-M'} = \sqrt{p.e_M^2 + p.e_{M'}^2})$
TAKE ALL READINGS TO RIGHT OF VERTICALS OR ALL TO LEFT.
SCALE FIGURES MAY BE MODIFIED BY ANY FACTOR WITHOUT AFFECTING THE ACCURACY OF THE RESULT PROVIDED THAT THE SAME FACTOR IS APPLIED TO ALL THREE READINGS : THUS DECIMAL PLACES MAY BE CHANGED AT SIGHT IF THE SAME CHANGE IS MADE IN ALL THREE SCALES.
$p.e_M$
$p.e_{M-M'}$
$p.e_{M'}$

gives double the values of the left. In using the nomogram care must be taken to read all values to the left of the verticals, or all to the right. Thus:

If the probable errors of the quantities being compared are 0.35 and 0.25, the celluloid strip is laid across the nomogram causing its straight line to intersect the left-hand scale of the left vertical at .35, and to intersect the left-hand scale of the right vertical at .25. The straight line then crosses the median vertical, reading from its left-hand scale, almost exactly at .43, which is the value to two significant figures of the probable error of the difference. If the two known probable errors had been 3.50 and 2.50, an identical procedure would have been followed and the result read as 4.30. Similarly, 0.035 and 0.025 would have given an answer to be read as 0.043.

If the first two integers of one of the two known probable errors are over 50, then the right-hand scales must be used. Thus, a straight line joining .85 on the right-hand scale of the left vertical with .30 on the right-hand scale of the right vertical is seen to intersect the median vertical, again using the right-hand scale, at a level a little above .90 which is, to two significant figures, the correct answer.

The usefulness of the device will depend, in any particular problem, on the number of differences to be appraised and on the degree of accuracy required for the probable error. In many anthropometric problems thirty or forty measurements and indices may be seriated for each of many sub-groups, and in such problems there are extensive arrays of differences to be considered. Probable errors of the differences are used only in order to find out if each difference does or does not exceed a given level of statistical significance,—usually three times its own probable error. In such cases, the probable error of the difference may be read at sight from the nomogram and the difference divided mentally by the result so obtained to decide whether or not each difference is to be considered as statistically significant. In most cases the answer will be unequivocal and, since we care little by how far a difference exceeds the level of probability which we have arbitrarily decided to use, so long as it does exceed that level, this is all that we are concerned to know. Since, in such problems, probable errors of the quantities being compared are generally reduced to two significant figures when computed, it may be doubted if a higher degree of accuracy in the probable error of the difference,—or in the "*X/p.e.*",—is other than fictitious

A few copies of this nomogram have been printed on good cardboard in a 9 × 12 inch size. They are available, together with satisfactory celluloid rules, to

those who write enclosing one dollar for each copy to the Division of Anthropology, Peabody Museum of Archaeology and Ethnology, Harvard University, Cambridge, Massachusetts.

JAMES M. ANDREWS
Peabody Museum,
Harvard University

A COMMON MISCONCEPTION CONCERNING THE BEHAVIOR OF LINKED FACTORS

OF the numerous misconceptions in regard to the behavior of linked factors, none is apparently more common than the concept that a correlation or an association in the general population between two genetic traits is an evidence of linkage. In 1925 Lauterbach (1), in his investigation of over 200 pairs of twins, found a higher incidence of left-handedness among the twins than in the general population, and erroneously assumed that such an association might be caused by linkage of the genes responsible for handedness and twinning. Numerous similar interpretations are on record, but we wish to refer especially to a recent article by Southwick (2) on factors for twinning.

In a previous article Southwick (3) presented conclusive evidence that fraternal and identical twins occur in the same kindreds with much greater frequency than should be expected if the causes of the two types of twins are independent. He assumed that such an association might be due to linkage of the factors operating to produce each type of twins. In the article under discussion Southwick has assembled data from 140 kindreds, containing 1,131 twins.

A curve has been plotted, which shows the percentage of like-sexed twins in the various kindreds. The curve is tri-modal, one mode at 100 per cent like-sexed, one at approximately 65 per cent like-sexed and the other at approximately 50 per cent like-sexed. Kindreds containing only identical pairs would, of course, be 100 per cent like-sexed, those containing only fraternal pairs should average 50 per cent the same sex, and kindreds containing both types should, according to Southwick's calculations, contain 64.37 per cent like-sexed pairs. He concludes that each type of twinning is due to a single recessive gene, and that these genes are linked. Kindreds containing 100 per

cent like-sexed twins are assumed to be in the repulsion phase, that is, the recessive gene for identical twins to be on the same chromosome as the dominant allelomorph of the gene for fraternal twins. Kindreds containing 50 per cent like-sexed twins are also assumed to be in the repulsion phase, the dominant allelmorph of the gene for identical twins being on the same chromosome as the recessive gene for fraternal twins. Kindreds containing around 65 per cent of like-sexed twins are assumed to possess "cross-over" chromosomes, containing both the recessive gene responsible for identical, and the recessive gene responsible for fraternal twins. In other words, these latter kindreds, and kindreds containing no twins are supposed to be in the coupling phase in regard to the genes under consideration.

The ratios of the various phenotypic combinations of linked factors tend to reach the same ratios as those obtained for independent pairs of factors. What these ratios will be, of course, depends upon the frequencies of the genes under consideration. The number of generations required to approximate such ratios depends upon the percentage of crossovers, the more closely linked the factors are, the greater being the number of generations required. Likewise, the type of mating and differences in survival values of the various phenotypes will affect the number of generations required to reach an equilibrium. As far back as 1917 Jennings (4) published formulae for determining phenotypic ratios of linked factors after a given number of generations of various systems of matings. Thus, unless the mutations have been comparatively recent, phenotypic ratios in the general populations afford no means for differentiating between linked and independent factors. Rather, the comparatively high frequency of kindreds containing both types of twins may be considered as a priori evidence against either linked or independent factors. Both types of twins should occur in the same kindreds with only extreme rarity, if each is caused by a single recessive gene, whether linked or independent, unless the mutations of both genes usually occurred in the same individual. In the latter event, which is highly improbable, we should expect kindreds containing both types of twins to occur with much greater frequency than kindreds containing twins of only one type or the other.

The widespread occurrence of both types of twins in man indicate that the mutations responsible for the two types of twins are by no means recent, and that they most likely have occurred many times.

Romulus and Remus, of Roman mythology, and Jacob and Esau of Jewish tradition, give evidence that the ancients were familiar with both types of twins. It may also be pointed out that while there is excellent evidence available that both types of twinning have a genetic basis, we know of no data conclusively demonstrating that either type is caused by a single pair of recessive factors.

In his previous article Southwick (3) suggested that the association between the familial incidence of the two types of twins might be due either to linkage, or to certain common factors operative in the production of both types of twins. While the suggestion of linkage is untenable, the concept that both types of twinning have certain causitive factors in common seems very reasonable. Pleiotropic genes in respect to two traits, plus independent genes for each, should give positive correlations for certain genotypic combinations.

Possibly the relationship of handedness and dermatoglyphics, and the high percentage of left-handedness in twins of both types, may also be the result of certain genes affecting more than a single trait.

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BIOCLIMATOLOGY AND BIOMETEOROLOGY IN BIOLOGICAL ABSTRACTS

MEN engaged in research in medicine, public health, ecology, agriculture, forestry, botany or zoology, geography, and other fields, will welcome the announcement that *Biological Abstracts* is undertaking a more complete abstracting and segregation of the current research literature in bioclimatology and biometeorology. The section *Bioclimatology-Biometeorology* will appear

within the section *Ecology* in *Biological Abstracts,* and will be under the editorship of Mr. Robert G. Stone of the Blue Hill Observatory, Harvard University.

The increasing interest in climatic and meteorological factors in their relation to biology, medicine, and agriculture is one of the significant trends of modern science. Ecologists have long appreciated the importance of temperature, humidity, radiation, barometric pressure, wind movement, and meteorological factors generally, as important factors in controlling the distribution and abundance of animals and plants. Foresters, horticulturists, and entomologists have likewise been concerned with the interrelationships of climatic and meteorological factors to the organisms with which they work. The developments of air conditioning and aviation have lately brought other important research groups into the field resulting in an increasing amount of research. This is often the work of individuals and groups not now in effective contact with biologists, and frequently appears in periodicals not commonly consulted by biologists.

In all civilized nations diverse research groups have sprung into being which, though they often devote much attention to the same fundamental natural forces, still work in practical isolation from each other, with a different background of training, and associations, belonging to different societies meeting at different times and places, publishing in different journals, reading different literature, investigating different types of things. These groups, however, are beginning to apply common ideas and common methods to the study of situations that are basically similar. For example, techniques and concepts derived from a study of the influence of weather factors on the spread of influenza or the common cold are likely to have a very high transfer value as applied to the study of the spread or survival of plant disease or economic insects. Conversely, it should be possible for research workers in the field of public health to make use of many findings of the entomologists, foresters, ecologists, plant pathologists, and other biological groups.

Under the sectional publication plan this material will be found, at present, not only in Section A, *Abstracts of General Biology,* but also under Section B, *Abstracts of Experimental Animal Biology,* Section D, *Abstracts of Plant Sciences,* and Section E, *Abstracts of Animal Sciences.*

RECENT LITERATURE

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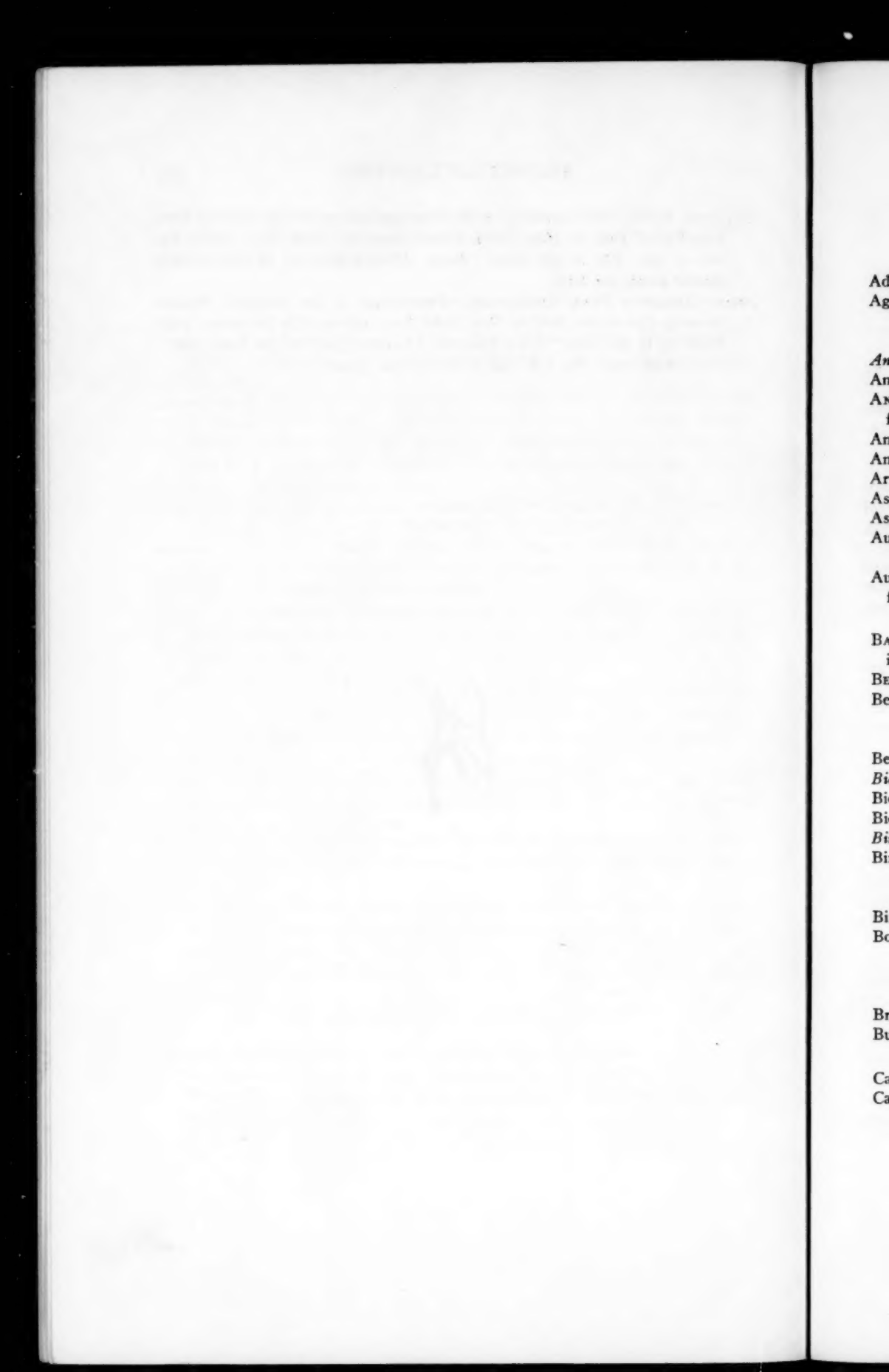

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